ENVIRONMENTAL ASSESSMENT BOARD

Ontario

ONTARIO HYDRO DEMAND/SUPPLY PLAN HEARINGS

VOLUME: 116

DATE: Monday, March 2, 1992

BEFORE:

HON. MR. JUSTICE E. SAUNDERS	Chairman
DR. G. CONNELL	Member
MS. G. PATTERSON	Member

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ENVIRONMENTAL ASSESSMENT BOARD
ONTARIO HYDRO DEMAND/SUPPLY PLAN HEARING

IN THE MATTER OF the Environmental Assessment Act, R.S.O. 1980, c. 140, as amended, and Regulations thereunder;

AND IN THE MATTER OF an undertaking by Ontario Hydro consisting of a program in respect of activities associated with meeting future electricity requirements in Ontario.

Held on the 5th Floor, 2200 Yonge Street, Toronto, Ontario, on Monday, the 2nd day of March, 1992, commencing at 10:00 a.m.

VOLUME 116

B E F O R E :

THE HON. MR. JUSTICE E. SAUNDERS	Chairman
DR. G. CONNELL	Member
MS. G. PATTERSON	Member

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D. COLBORNE		NIPIGON ABORIGINAL PEOPLES' ALLIANCE
R. CUYLER		ON HIS OWN BEHALF

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L I S T o f E X H I B I T S

L I S T o f U N D E R T A K I N G S

TIME NOTATIONS

---Upon commencing at 10:03 a.m.

THE REGISTRAR: Please come to order. This hearing is now in session. Be seated, please.

THE CHAIRMAN: Mr. Shepherd?

MR. SHEPHERD: Mr. Chairman, we promised you Mr. Grenville-Wood this morning, but he has asked that we change with him, and he is going to go tomorrow morning, I think.

Before I start, I would like to file the new exhibits I promised on Thursday. This is a package of seven exhibits, numbers 499 through 506, inclusive, and if it is okay with you, Mr. Chairman, I am going to introduce each exhibit as I get to it and explain what it is.

---EXHIBIT NO. 499: United States Department of Wind Energy Program Information.

---EXHIBIT NO. 500: The potential of Renewable Energy: An Interlaboratory White Paper.

---EXHIBIT NO. 501: California's Success with Renewable Energy and Efficiency.

---EXHIBIT NO. 502: Two News Reports in the Status if Fuel Cell Generation of Electricity.

---EXHIBIT NO. 503: California Energy Commission 1991 Energy Technology Status Report Excerpts.

---EXHIBIT NO. 504: Photovoltaics in the Distribution System: the Evaluation of System and Distributed Benefits.

---EXHIBIT NO. 505: Jobs from Electricity Generation.

---EXHIBIT NO. 506: Solar Two Fact Sheet.

THE CHAIRMAN: That will be fine.

MR. SHEPHERD: And finally, we promised a video, and we are not delivering because we weren't able to get it edited properly. There is, of course, an alternative, and that is, we could have a field trip to California to look at the stuff that was on the video, and you might wish to consider that.

ARTHUR RAYMOND EFFER,
CHARLES WILLIAM DAWSON,
JAMES RICHARD BURPEE,
GARY NEIL MEEHAN,
JOHN DOUGLAS SMITH,
AMIR SHALABY; Resumed.

CROSS-EXAMINATION BY MR. SHEPHERD (Cont'd):

Q. Mr. Shalaby, the last thing you said on Thursday just before we left for the day was that hydrogen is a manufactured fuel, and you contrasted that with other fuels, and that is the reason why you excluded it or one of the reasons why you excluded it from your fuel cell analysis even though it is cleaner. That is the reason you gave; right?

MR. SHALABY: A. That was a description of hydrogen, that it is not an alternate energy form. It is a manufactured product rather than a naturally occurring product, yes.

I don't know whether it is excluded from

the fuel cell analysis. We are showing fuel cell economics with natural gas getting reformed into hydrogen. We expect that if we put pure hydrogen in there the cost would probably be a little higher.

Q. But it would also be a great deal cleaner, wouldn't it.

THE CHAIRMAN: Sorry?

MR. SHEPHERD: Q. It would be a great deal cleaner, wouldn't it?

MR. SHALABY: A. Again, my answer, I remember it to be, it depends how the hydrogen is made. At the combustion point, at the point of use, you are quite right. If you use hydrogen instead of a petrochemical fuel it would be cleaner at the scene, yes.

Q. Of course, what you really do in a natural gas fueled fuel cell is you manufacture a hydrogen rich gas in the reformer; right?

A. That's correct.

Q. We were talking about the various choices that were made in terms of technologies that were analyzed in the alternate energy review.

I noted, for example, it is true, isn't it, that the environmentally preferred ways of using peat as a fuel would be pellets, briquettes or in the

longer term syngas; that's correct, isn't it?

MR. DAWSON: A. I'm not sure why pellets or briquettes would be preferred over the method that we describe which is currently the most popular.

It may be. I'm not disputing it particularly, but I can't see particularly why.

Q. Aren't the emissions substantially lower when you use the more refined products?

A. As far as I know, the only difference between pellets or briquettes and milled peat would be potentially the moisture content.

Q. Mr. Shalaby, is there a lot of professional judgment in the alternate energy review?

MR. SHALABY: A. Yes.

Q. Presumably the usefulness of the judgments in the alternate energy review is directly related to the expertise and training of the people making the judgments; is that fair?

A. And the resources they have access to, yes.

Q. Okay. I noted with interest Mr. Greenspoon's question in Volume 112 at page 19607. You can turn to that if you want to.

A. The page number again, please?

Q. 19607. And his question is at line

11. He said to the effect: What about these rumours that the alternate energy review was written by a bunch of out-of-work nuclear scientists? And your answer was, "I told you who wrote the report."

Well, I looked around for where you did that, but I couldn't really find where you had already answered his questions, in effect.

And then, when you said the other day that the former head of the project had gone to the Pickering Nuclear Generating Station I wondered again. So I am just going to ask you straight out: Is it in fact correct that a substantial number of the people working on this report are from the nuclear side of Ontario Hydro?

A. The person that was heading the study is a civil engineer. The co-chair that chaired the group after that is from Corporate Relations branch. Others were people from the Research Division; from System Planning Division; three people from Design and Development Division, these are the specialists in the alternate energy business; one person from Dr. Effer's department, Environmental Studies; and assistance from external consultants.

That is the answer I gave to Mr. Greenspoon, maybe not in this much detail, but that was

the team that was put together to do the day-to-day work on the report.

Q. I appreciate the description. I guess all of those divisions and departments that you have mentioned have groups within them that work on nuclear research or nuclear development work?

A. That's correct.

Q. So, within that answer, of course, we could have had the whole team being nuclear people working on alternate energy.

I am asking the specific question: Was it a bunch of a nuclear engineers and nuclear physicists who wrote this report?

A. My answer is clear. There were three experts that do nothing for the last 10 or 12 years in their career in Hydro other than alternative energies. There were the core people who provided the expertise.

The corporate relations person who contributed to the thermal cost review is familiar with the format, the costing methodology and the methodology displaying various options and costing them in a consistent way.

Q. That person is not a person whose background is nuclear?

A. No, it is not.

Q. Okay.

A. A consultant whose background is not nuclear; an assistant planner who works in Mr. Meehan's department for the least several years, maybe two or three years, he might have worked before that in the operating side of the house and perhaps on nuclear matters, but certainly he is a generation planner for the last three years or so.

The team leader is a civil engineer, and he is related to the nuclear side of the house, on the civil side of the engineering.

Now, you make it out. Is that a nuclear group working on --

Q. You described about eight people that were involved in it. Is that about right, it was about eight people?

A. That were involved on a full-time basis, yes. There were others involved on an on-and-off basis and consultation.

Yes, the one I didn't mention in detail was the scientist from Dr. Effer's group. I don't exactly know whether he is a biologist or not, but I suspect he is in the natural sciences side of the house, certainly not in the nuclear side.

DR. EFFER: A. I don't have any nuclear

engineers working for me.

Q. The record should record the big smile you had on your face when you said that.

Mr. Shalaby, in the alternate energy review you analyze certain technologies using cost/benefit analysis, solar, wind, municipal solid waste, and you analyzed others such as fuel cells, biomass and peat using levelized unit energy costs.

Can you just briefly explain again why you would do some differently than others?

MR. SHALABY: A. We provided both pieces of information on all the options, but we felt that it is more meaningful to look at cost/benefit ratios for options that are not dispatchable.

And for the municipal solid waste we felt the cost/benefit analysis can capture the tipping fee benefit as part of the operation.

Municipal waste incineration or landfill gas operation would benefit from both the electricity purchase price and perhaps costs related to reducing the landfill costs, whether it is tipping fee or burning off the methane or something like that.

[10:15 a.m.]

So the municipal waste, we are catching extra benefit; the solar and wind, because they are not

dispatchable, then the energy they produce has different value at different times of the day, different times of the year and we match those one to one. As I explained in my direct, we did that for hydraulic energy, for example, Panel 6 here displayed the cost/benefit ratio as a measure of different hydraulic resources and explained why that's an appropriate way of measuring cost benefits.

Q. Can you confirm that the cost/benefit analysis includes only benefits considered valid by Ontario Hydro, that's, in effect, the system incremental costs of capacity and energy to Hydro?

A. Plus a 10 per cent renewable --

Q. Plus the preference premium, right.

A. Yes.

Q. And when you do the LUEC analysis --

A. And transmission distribution credits, as well.

Q. Those are in system incremental costs; right?

A. Yes. They are added to it depending on how deep into the distribution network.

Anyway, I just wanted to make sure that we mention transmission distribution.

MR. DAWSON: A. Would you just repeat

the question again. Confirm that...

Q. When you do the cost/benefit analysis the only benefits that are included in that analysis are the system incremental costs associated with the capacity and energy, and Mr. Shalaby has clarified that that includes transmission and includes a preference are premium but otherwise that's right.

A. Well, in the case of municipal solid waste it includes the tipping fee too.

Q. Good point. All right.

I wanted to ask you a question about that. Municipal solid waste, municipal waste generally whether it's mass burned or landfilled gas is not really primarily an energy technology, is it. It's a waste management activity; isn't it?

MR. SHALABY: A. Yes.

Q. Now, when you do the LUEC calculation is there a preference premium in there as well?

A. No, the LUEC is the cost of producing electricity from a particular facility. Only when you start comparing it to the benefit would you include the premium. So the LUEC does not include a premium.

Q. So then if the preference premium technique is valid, isn't it true that you can't compare the LUEC of one thing to another thing directly

without considering that other impact?

A. If you are comparing the LUEC of biomass, for example, yes, you want 10 per cent premium before you discard that option.

Q. Fair enough.

For a number of the technologies analyzed in the alternate energy review, Ontario Hydro has estimated costs in the year 2000 and beyond. How did you arrive at those estimates?

A. Several methods. Mostly cost estimates by external laboratories and experts, projections by people like U.S. Department of Energy, Energy, Mines and Resources Canada, projections from our own experience as to what the costs might come down to. But most of the estimates were extracted from large national laboratories like Energy, Mines and Resources and like the U.S. Department of Energy studies.

Q. So I assume then that you are fairly confident that your longer term estimates are consistent account estimates of other players such as utilities, government departments, labs, et cetera, that have analyzed the same markets?

A. They are not terribly out of whack, yes. Though that is a dynamic market. Your own

exhibit shows how, for example, California Energy Commission slashed down the costs of wind from 13-, $1,400 a kilowatt to 7- or $800 hundred a kilowatt almost overnight or within one report cycle.

Q. Two years. Within two years?

A. Within the one report cycle, yes.

So it's a dynamic market. Other technologies, estimates for them go up in price.

Q. Of course.

A. For example, photovoltaics, there was a lot of projection in the past that the targets set by the Department of Energy would be met. Targets were set in early 80s. Now people don't feel those targets will be met, so the costs are a little higher.

Q. That is a timing question?

A. A timing question yes, that's right.

Q. Right.

A. So all I am saying is we try and keep tabs on what people in the industry and in the business are saying, but we recognize that they change what they are saying as well. You can't catch them still at one place for any length of time.

Q. Reading through the alternate energy review one is struck by the fact that you have instituted what appears to be a consistent policy high

of excluding the benefits of producing in cogeneration mode particularly where technologies are naturally suited to that, that affects biomass and peat, of course, but also most importantly it has a very large impact on fuel cells. Can you tell us why you excluded the benefits of -- why you modelled them, in effect, in a sub optimal way?

A. I think we recognize in the report that those technologies can be much more economic if employed in cogeneration facilities, particularly fuel cells, and we indicated the value of the steam or the thermal energy, we quantified it in dollars per gigajoule. So we acknowledged what it is that it could be additional benefit from cogeneration.

The difficulty in doing an analysis combined as a cogeneration is that we don't know what the incremental cost of, for example, fitting a building with both electricity and heat utilization from a fuel cell. There will be additional facilities involved in generating heat or using the hot water off the fuel cells or steam or something like that. We prefer to show what the benefit is and we don't know what the costs of cogeneration utilization will be.

It would have made the analysis more complicated. This is sort of saying, to make

electricity that's what it would cost. If you could also use steam or hot water you could get another dollar or two per gigajoule in benefit. And in the particular case of fuel cells our estimated potential relies heavily on the idea that it could be located in large industrial and institutional buildings where they would use both electricity and heat energy.

Q. When we read your LUECs or your cost/benefit analysis, in none of the technologies does that include the cogeneration benefits; does it?

A. It's included separately. I don't want to the say that we included them combined. We didn't combine them but we provided information that you can look at the costs of producing electricity and the benefit of using the steam, and you can add one to the other. But the straight answer to your question is your correct, yes.

Q. I am not suggesting you mislead us. I am trying to get an idea of how we look at the LUEC and the cost/benefit numbers?

A. It's strictly generating electricity. The LUECs are strictly electricity generation.

Q. So because they are strictly generating the electricity, in the case of heat producing technologies like fuel cells, the model on

which the numbers are based is not the optimal model; is it?

A. You are correct. If there is an opportunity for cogeneration, there is additional benefit, and we discuss that in great depth.

Q. Undoubtedly.

A. Yes.

Q. The alternate energy review, that wasn't field --

A. Just for the record, maybe I should say that page 90 of Exhibit 344 shows in figure 3-10-12 the potential value of usable heat for the fuel cell options. And there is a value of heat in levelized unit energy benefit really in there, it varies between about 1 cent and 2.4 cents per kilowatthour. So it's put in here. It's just the combination gets messy, that's all.

Q. The alternate energy review wasn't field studies, was it? It was a literature review, in essence.

A. Yes.

Q. What limitations are placed on the results of such a study as opposed to going out and doing proper field studies?

A. Maybe you can tell me what proper

field studies mean in your own mind and I will detect from that what limitations.

Q. Let me rephrase the question. A literature review isn't the most detailed or scientifically rigorous way of analyzing a problem; is it?

A. Well, if we had five years that we can get facilities and test run them in different conditions, we would get more data perhaps. Yes, it has limitations.

Q. It is true, isn't it, that in some areas you have expressed the information limitations as to being of significance importance; right?

A. What examples can you give of that?

Q. Well, haven't you said that is a factor in fuel cells, in photovoltaics, in wind?

A. I expressed the opinion that in wind, for example, lack of detailed knowledge of good wind sites is a significant limitation in determining the ultimate potential in Ontario. Without a good rigorous resource assessment in Ontario of wind conditions at specific sites over a long period of time, any projections of wind potential would be fraught with uncertainty and limitations. So that's an example of a field study that can yield a lot more useful results

than a desk study, if you like.

Although the estimates that we have rely on other field studies, they are not all, you know, desk studies done to one another. Some of though studies have been to the field and have done measurements.

[10:25 a.m.]

Q. Yes.

A. In fuel cells the limitation in our estimate has to do with the acceptability of fuel cells in a large institutional building, whether a university or a hospital or a prison or some large user of heat and electricity would have acceptance of a fuel cell operation.

We know that some administrators of these institutions welcome the energy savings and the independence that a fuel cell might offer; others would not want the complications of running a power plant in addition to their business.

So without detailed knowledge, again, if you go and have a more rigorous survey the penetration rate of fuel cells in that market could be refined a bit.

So we have approximations in saying that we expect roughly 20 or 30 per cent penetration in that

market over that time period. That was a judgement call that can be perhaps refined and bettered by more extensive marketing studies, for example.

So yes, there are limitations of a study of this nature.

Q. Okay. Last Wednesday Mr. Starkman asked you questions about how much you spend on R&D in the alternate energy area as compared to fossil, large hydro, nuclear, et cetera.

Do you recall that discussion?

A. Yes, I do.

Q. As I understand your answers, you spend about 20 per cent as much on renewable energy, not including large hydro of course, as on fossil or large hydro, and about 2 per cent as much on renewables as on nuclear.

Am I in the right range there?

A. You are probably in the right range. I referred to particular interrogatory responses and those are the answers, but for the sake of this discussion you are in the right range, yes.

Q. Even within the alternate energy R&D if we looked at the details of that budget -- it is only in the hundreds of thousands; right?

A. That's correct.

Q. If we looked at the details of that budget we would see a lot of off-grid stuff and a lot of attending conferences and things like that. We wouldn't see anything really on grid applications, hard R&D on grid applications, would we?

A. I think it includes all of what you mentioned, yes. But whether there are no dollars for hard grid applications, I have to think about that.

If you are testing a fuel cell, for example, at our Kipling Research Laboratories, would you classify that as...what? Is that hard R&D for a grid application or is it --

Q. Isn't the one you are testing one that you have already said does not have a grid potential? Isn't this the solid alkaline or something, solid polymer one?

A. No, it's phosphoric acid. It is phosphoric acid, 40 kilowatts.

Q. It's a PSE?

A. That's right. There is a picture of it in the report.

Q. Confused me a bit.

A. The distinction between, for example, photovoltaic research that is for grid application or for remote application is a fine line, and the panels

and the technology and the converters and the power conditioners work equally well in one application as they do in the another.

The knowledge you gain in remote applications can be in a large measure transferred to the grid applications as well, or a good portion of it, things like solar cell life efficiency, converter operation, all of those things can be transferred to the grid, that knowledge, and that experience is transferable.

All I am saying is the research may be designated for remote or for other applications, but there is a rub off and benefit on the grid application as well.

Q. So you would have learned a lot, then, from, using in Fort Severn, a wind turbine that nobody manufactures, not connected to a grid, you would still learn a lot about whether wind energy would have grid application in Ontario?

A. I think the objectives of the Fort Severn - and I just got your interrogatory that you may be intending to refer to - there were objectives to do with determining maintenance requirements in a remote application, in determining how a wind turbine works with a diesel generator at such a high penetration

level, a large wind turbine with an equally large diesel engine, and there were objectives to do with the cost of that operation in a remote site.

So the objectives of the Fort Severn application were quite specific. The demonstration and the research and development work were specifically towards remote applications.

Some of the things you learn here can be transferred to a grid connected application, but perhaps not many.

Q. Are you familiar with an organization called PVUSA?

A. Yes, I am.

Q. Can you tell us what it stands for?

A. Photovoltaic Utility Scale Applications.

Q. And what is that?

A. I am becoming the specialist in acronyms in this hearing. I am quite proud of it.

Q. We all have a role.

A. I get distressed at the amount of trivia I retain in my mind.

That is a photovoltaic demonstration facility in the Pacific Gas & Electric utility area, and it is a consortium by many manufacturers and

utilities, and I think EPRI as well, the Electric Power Research Institute, to test out on a large scale, meaning 200 kilowatts at a time, various manufactured photovoltaics under different test conditions in a real-life utility grid connection.

Q. Wasn't the primary rationale for the establishment of PVUSA and the investment of substantial amounts of money by utilities, wasn't the primary reason the fact that the smaller scale, off-grid type of research that had been done elsewhere simply wasn't answering the utility's questions about photovoltaics?

A. If you do it in the scale that PVUSA is intending to do you get closer data and much more relevant to a large scale utility application, yes.

Now, I wouldn't say that the earlier experience is irrelevant, but it may not answer all the questions. It certainly answers some of the questions, but there are more to be answered, and that is why they instituted that demonstration.

Q. There are a number of utilities, in the U.S. at least, investor-owned utilities, that spend a good deal more than Ontario Hydro on alternate energy R&D; isn't that correct?

A. That is correct.

Q. PG&E, for example, might spend ten or 15 times as much as Hydro?

A. I wouldn't be surprised.

Q. Why is that?

A. I wonder whether they are better answering that kind of question. But for one thing, they are getting a larger portion of their energy from some of these alternate energies than we are. For example, they are getting something like 1 per cent of their electricity, to my understanding, from wind and perhaps more than that from geothermal.

They have large geothermal resources in their territory and they are working hard on the photovoltaic demonstration. So their climate and their territory has larger potential for some of these alternatives. They are extracting a lot of energy from them, and therefore, they are spending more money to learn about them and understand them.

Q. Of course, another utility that spends a lot more than Ontario Hydro on alternate energy is Niagara Mohawk; right?

A. I'm not sure of that, but I wouldn't be surprised either.

Q. Niagara Mohawk is, what, about a tenth the size or so of Ontario Hydro?

A. I'm not sure of that. It is a smaller utility in the New York service territory, yes.

Q. They certainly don't have a lot of deserts or mountain passes where there is a lot of wind; they don't have a lot of renewables on their system now, do they?

A. No, they don't. I am not familiar exactly with what their budget is and what the areas of their research are.

I am familiar, for example, that they are part of a wind energy utility working group. I forget what it is called, but U.S. Wind Power, Pacific Gas & Electric, and Niagara Mohawk, and EPRI formed a group, and Ontario Hydro is monitoring them as a member in that group as well, to develop a variable speed wind turbine, for example.

Q. Sorry, Ontario Hydro is a member of that group?

A. Yes.

Q. Is that very recent?

A. Well, the whole group is very recent, yes.

Q. Well, it is just that the stuff I got from them a few months ago didn't have Ontario Hydro listed on it. I am just wondering --

A. Well, they invited all utilities to participate and to follow the activities of that group and to attend their meetings.

Now, there are some that are sponsoring and others that are members in the sense of attending and sharing the information. My understanding is that we are in the group that is attending and sharing the information.

Q. Oh. Okay. Different kinds of members?

A. I'm not exactly sure whether they call them different kinds of members or not. I presume a member that sponsors is different than one that doesn't, yes. They have an east council and a west council, and, to my knowledge, the east council is the one that Niagara Mohawk would be a little more interested in.

Q. Could you take a look, please, at Exhibit 501? This is in that new package I gave you.

Mr. Chairman, just to introduce this, this is the text of testimony given by the Chair of the California Energy Commission before the U.S. House of Representatives in December.

Mr. Shalaby, if you could look at page 4 on the last paragraph?

MR. SHALABY: A. Can you tell me again what it is?

Q. This is Imbrecht's testimony to the House of Representatives in December, Imbrecht being the Chair of the California Energy Commission.

A. Yes? Page 4?

Q. Page 4, last paragraph, about the middle of the paragraph, he says:

> "This means that for every dollar spent on renewables O&M, an additional 28 cents is created in the economy compared to the same dollar spent for fossil plant related O&M."

What he is doing, he is describing the economic multipliers associated with the various technologies.

It is true, isn't it, that renewable technologies generally have greater multipliers, economic multipliers, than conventional technologies; they create more economic activity per dollar invested. Is that correct?

A. I am not sure whether that is universally correct or not, whether in California that is the case, whether that is directly transferable to Ontario or not, I have no idea.

Q. Has Ontario Hydro not looked at that?

A. I don't think to that great detail the operation and maintenance costs, the multipliers of those related to wind and solar as opposed to fossil, not to my knowledge.

Q. In your review of alternate energy technologies did you at any time review the literature on or do any direct studies on the relative economic effects of those technologies as opposed to conventional technologies?

A. Are you going to the relative economics in the sense of employment, is that what you are talking about?

Q. Creation of economic activity, yes.

A. I think there is a brief examination of employment and socio-economic impacts on each of the technologies in Exhibit 344, but I don't expect that it went into the detail to quantify things like for every dollar there is 28 cents of spin-off.

The reason it is difficult to do here in Ontario is we don't have a large, established wind or solar energy to know exactly how the dollar of maintenance spins off other employment or other facilities. We don't have the data base to make that kind of determination.

Perhaps in California where it is a

multi-billion dollar industry for the last 10 years they have accumulated enough data to be able to extract that kind of information from it.

Q. California went through a massive shift about 10 years ago from conventional technologies to alternate energies, technologies and cogeneration; isn't that right?

A. Yes.

Q. If you could turn to page 6 of Exhibit 501, Mr. Imbrecht talks about the impact of that in California. He says it was an $8 billion investment.

MR. HOWARD: Where are we now?

MR. SHEPHERD: We are right in the middle of the page where it says "Since 1982..."

What he says is, it was an $8 billion investment, the return was over $30 billion, and it translates into 293,000 jobs.

[10:40 a.m]

Q. Has Ontario Hydro done any studies or another analysis to determine whether such impacts could be duplicated in Ontario with different electricity generation policies?

MR. SHALABY: A. No.

Q. I wonder if you could turn to Exhibit

505.

A. We have done some impact work on employment and impact of GDP for cogeneration, for example. That is part of -- I am trying to remember the exhibit number, but some of the early strategy work that we have done we have shown that cogeneration in Ontario, for example, has a high economic multiplier, small hydraulic as well.

Q. That was part of the demand/supply options strategy; wasn't it?

A. That's correct, yes.

So we have shown that some waste, wood waste use or cogeneration or small hydraulic has high employment potential in Ontario. But to go as far as what 9,000 megawatts would do in terms of employment over a decade, that's again a much larger job than saying a particular site creates so many jobs. So we haven't done it in that extent.

Q. You had a discussion the other day with Mr. - maybe it wasn't you, maybe it was Mr. Meehan - had a discussion the other day with Mr. Heintzman concerning the relative jobs created by fossil and nuclear. Do you recall that?

A. Yes, I do.

Q. If you could turn to Exhibit 505,

this is a chart of the job creation impacts of electricity generation technologies, the source you see there. And this shows, for example, that wind energy creates about five times as many jobs as either nuclear or fossil.

Is this consistent with the information currently available to Ontario Hydro?

A. You have got to ask where is that. If you go to Denmark, for example, where they make wind turbines but do not make nuclear reactors, sure, wind turbines will create more employment than buying a nuclear reactor designed and assembled outside of Denmark and probably fueled by uranium mined and manufactured outside of Denmark. So I think that kind of story is very location and territory specific.

Is that meant to be universal, that wind anywhere in the world will create more employment than nuclear anywhere in the world? I doubt that very much.

Q. Okay.

A. So if you are at a place that makes wind turbines and not nuclear reactors you are in a very much different situation than if the reverse is true.

Q. Currently there is no manufacture of wind turbines in Ontario, is there?

A. I don't know what the status is but there used to be a few. I don't know whether it's still in the business or not.

Q. But there is manufacture of nuclear reactors in Ontario, nuclear components?

A. I could probably say the same thing, there used to be a few and I don't know whether they are still in business today or not. [Laughter]

DR. CONNELL: Before we leave this, I would be interested to know from the original study what is the definition of direct employment. Does that mean employment on site, engagement in the actual construction and operation of the facility?

MR. SHEPHERD: Dr. Connell, the original study, as I understand it, included all manufacturing jobs and other things that were the direct result of the wind powered generation, but didn't include economic spin offs, the sort of normal multipliers through the economy.

I would be happy to get the study and table it, if you wish.

DR. CONNELL: Actually, I have a copy at home and I can look it up.

MR. HOWARD: With the greatest respect, I haven't been objecting to my friend introducing bits

and pieces from all over the world and he has got a couple of inches from California, but it seems to me, Mr. Chairman, that if what my friend is doing is introducing one page from World Watch and then giving evidence as to what is in it, we are going to be here forever.

I respect Dr. Connell looking it up at home, but if it isn't favourable to Ontario Hydro I would like to know what conclusion he comes to.

We are getting into an absolutely intolerable situation.

THE CHAIRMAN: This comes up quite frequently.

MR. HOWARD: Yes, that's why I have been quiet.

THE CHAIRMAN: Exhibit 505 is not, in my view, evidence. It only used as an aid to elicit evidence from this panel. To the extent that they can present evidence they can, if they can't they aren't able to. But I don't regard Exhibit 505 as evidence in this hearing.

MR. SHALABY: I may note for Dr. Connell's information that the author of Exhibit 505 is Mr. Paul Gipe who is also the author of Exhibit 409 put forth by Dynamo Genesis. And my information when I

read that, that Mr. Gipe is a wind energy expert based in Tehachapi.

Is that correct?

MR. SHEPHERD: Q. No, I don't think 505 was --

MR. SHALABY: A. Or at the time he wrote 409 that was the credentials given.

Q. I don't think 409 is prepared by Mr. Gipe. I think the source is the World Watch Institute which has nothing to do with Mr. Gipe, as I think you know.

THE CHAIRMAN: I think we are getting, way beyond the scope of this particular...to get into that kind of discussion.

MR. SHEPHERD: That's right.

Q. Well, Mr. Shalaby, perhaps we could turn and look at wind energy in more detail.

Mr. Chairman, as you know, our other client, if you like, is the Canadian Wind Energy Association, so we may go into a little more detail in wind energy than we might otherwise.

Wind energy is a commercial scale maturing technology; is that correct, Mr. Shalaby?

MR. SHALABY: A. That is correct.

Q. Would you say it's a more mature

technology, more commercial level technology than integrated coal gasification which is another one of the technologies Hydro is interested in?

A. Probably the megawatts installed are in the same order of magnitude as integrated coal gasification or perhaps even more.

Q. I am asking about the stage of development that the two technologies are at?

A. I would accept your proposal, yes.

Q. There is however still development work going on in the technology. It's not as mature as, say, hydraulic where there is very little room to have move?

A. There is still work going on, yes.

Q. The result is that costs are projected to go down in real terms by virtually everybody; is that correct?

A. Yes.

Q. There are also expectations of substantial manufacturing economies of scale?

A. Yes.

Q. You mentioned earlier, you talked about the wind resource in Ontario, and it has been said a number of times that Ontario isn't a very windy place; is that correct?

A. Yes.

Q. In general, isn't it true that it is not the windy jurisdictions that have tended to have the most wind energy development?

A. Well, if you are referring to California, again Exhibit 409 is an exhibit that shows why wind energy development have taken off in California and it makes a point that California in fact is not the windiest place is in the United States. The midwest and the Rockies and places like that have much larger and much better wind resources than California has. So it's not just the wind resource, it's other conditions as well that kicked off the industry in California.

Q. Could you turn to page 6 of Exhibit 499. Now, Exhibit 499 is a package of information from the U.S. Department of Energy. They are one of the sources you used for information in doing this sort of study; right?

A. Yes.

Q. And page 6 of Exhibit 499 is a wind resource map of the United States.

A. That's correct.

Q. It is divided up, I guess it's fair to say that the darker the shading of the state, the

more wind resource there is; is that fair?

A. I wish you had one that showed wind speeds, because Mr. Greenspoon wanted one of those.

All right. Go ahead. Save me an undertaking.

Q. So this shows essentially what you said, right, that California isn't one of the windier places in the United States?

A. Yes.

Q. Fair?

The other place where wind power is developing which is Oregon, that's also not one of the windier places, but places like Texas, Montana, they are very windy and have no wind turbines; right?

A. Not as significant has California.

Q. Another utility that's very interested in wind power is Niagara Mohawk and that's in New York which is also not very windy; right?

A. According to go this map, not as good as some of the better wind sites, yes.

Q. In fact, if Ontario were on here too we would be sort of in the same category as California and New York, wouldn't we, in terms of overall wind resource?

A. I'm not sure. In aggregate you may

be right.

See, in California, the entire state is not a good wind site. There are very specific mountain passes that are windy. Some of the wind maps that I have seen would show three or four dark dots within the California landscape that are windy.

Like this map here is showing an average thousands of megawatts, but if you were presented a map that shows a wind resource, you will find a few dark spots in California. The mountain passes are particularly windy, but the state in general perhaps is not.

DR. CONNELL: Could someone explain what we are looking at here before we carry on?

Just interpret the data for me.

MR. SHEPHERD: What DOE has done, or I guess it's Pacific Northwest Lab has done is they have said, what is the total wind resource in each state in megawatts -- sorry, in thousands of megawatts. So they have said, for example, total wind resource in California is 7,000 megawatts, but in Texas it's 136,000 megawatts.

DR. CONNELL: Is this covering the entire state with turbines?

MR. SHEPHERD: No. This is just using

the places that are places where you can produce wind power.

DR. CONNELL: What is the criteria, minimum velocity and duration?

MR. SHEPHERD: It's actually more complicated than that. I am happy to actually table that study which is a very interesting study.

DR. CONNELL: What does 10D by 5D mean?

MR. SHEPHERD: That's 10 diameters by five diameters. That's the diameter of the blade.

Q. Mr. Shalaby, have you seen this before? This is from Battelle study, are you familiar with that?

MR. SHALABY: A. I seem to remember something like it. Whether it's exactly that or not, whether it was presented at the wind energy conference in Montreal, I suspect there was. There were slides ahead of that, to my memory, that showed the exact wind map, if you like, and the wind resource, and that one was very interesting as well.

Q. Can you confirm that my explanation of this is correct?

A. It is generally correct, yes.

Now I am not sure what the criteria are exactly, but generally they are saying if extensive

development in these areas, you will get that kind of power.

Q. Now, you mentioned a number of times wind speed maps as opposed to wind resource maps, and you said in your direct evidence that mean wind speed maps have a very limited usefulness; correct?

A. Yes.

Q. In fact, isn't it true that such a map is unlikely to give any meaningful information on the extent of the wind energy resource in Ontario?

A. It gives a preliminary indication, if you are a prospector for wind resources and you are free to go anywhere, you probably wouldn't come to Ontario, you will go somewhere else first.

But yes, it has limited information. I liken it to, for example, a geological survey that would show you in general what the geological make up of Ontario is, but if you want to go and prospect for gold you have to go out and dig and pick and go walk the trail and see whether you find what you are looking for.

Q. Great analogy.

The map on page 43 on the alternate energy review, that's a mean wind speed map; right?

A. Yes.

Q. Is it fair to say that this map without further work, this map simply doesn't tell us whether we have the sort of resource that California has or not?

A. Without further work it gives you an indication that there are limited areas in the province that have higher wind speeds than others, and we mentioned Sudbury, I think we mentioned the shores of the Great Lakes.

[10:56 a.m.]

It gives you an indication of the average wind resource. It has some information that is useful.

But it is not, as I said in my evidence and as we are confirming now, the only information that a serious wind prospector would rely on. They would not rely on that data. They would go and do their own measurements, as I said, for a continuous period of time in specific locations.

I can't overemphasize, and I know you know this, that the site-specific nature of wind is paramount. You have got to go and find a site that can harvest the wind better than others.

And sites, to my knowledge, that are even 500 metres away from good sites could be very bad sites. We are told that in wind farms, for example,

you can have a wind turbine here and a wind turbine 100 metres away, and this one would harvest five times as much energy as the other one only 100 metres away, just to indicate the sensitivity of siting and the specific conditions to the extent of harvesting the wind.

So it is not something that you can see on a map of Ontario. You know, we are talking about very, very specific differences in siting.

Q. Well, the level of detail on a map like this is also, I guess, going to be very relevant right, the level of detail? You have here, for example, an area of what looks like 100 kilometres around Sudbury which is at 20 kilometres per hour.

A. Yes.

Q. 20 kilometres per hour is still not a good enough wind regime for most wind turbines, is it?

A. Not if it was exactly 20 kilometres per hour. It has got to be better. Although, again, people are promising developments in the technology that would harvest that kind of wind regime, but for today's mature technology I am told that that kind of wind speed is not economic to harvest.

Q. But if this map were drawn at a greater level of detail then we would start to see some places where there was better wind; right?

A. Perhaps, yes. Yes.

Q. In fact, if you drew a map of California at this level of detail you wouldn't see Altamont, Tehachapi or San Gorgonio, would you?

A. No, the maps I have seen do show these three mountain passes as dark blips, a little better resource than the rest of the map.

Q. These are the maps produced in the '80s after development took place there and anemometer were put up by the developers?

A. Perhaps. Perhaps that without those detailed measurements the maps would not have shown, and, as was mentioned here, much of this data is airport wind measurements, and somebody said that airports by design are put in places that are not windy.

So you are quite right. It could be that without detailed studies you will not identify the wind sites.

I think we are in total agreement that detailed wind prospecting is the useful way of identifying the wind resource, and this kind of map has limitations and only indicative of what kind of wind resource we are talking about in general. But it has limitations.

I think we felt we would put that in rather than be silent and say there may be wind, there may not be wind. That is the reason for putting that map in.

Q. You in fact have some better data than this, don't you - not in the report, but you have available to you better data than this?

A. Well, even in the report we showed you wind -- the next page right up shows wind speeds at Fort Severn and at the Kortright Centre, and again, it is to give an indication that wind speed is not a single number; it is really a daily variation in wind speed as shown on these two graphs, and I introduced them in my direct evidence.

A distribution of wind speeds is important, not just the average. For example, an average of eight metres per second can be an average of a range between seven and nine. That would be a good wind regime. Eight can also be the average of one and 17, and that may not be as good a wind regime, or one and 15 for example.

If you have very, very windy gusts and very quiet times and the average is still eight, that is not as good a regime as a steady 7, 8, 9 all the time.

Q. Gee, I had understood the opposite to be true, that it was much better to have a wind regime where you had sometimes at 12 metres per second and sometimes at nothing because at 12 metres -- there is a rule that says that, or a law of nature, I guess, a law of physics, that says as the wind speed goes up the power goes up exponentially; right?

A. That is correct, but there is a place when you start getting into very high wind speeds that the turbines shut down. They protect themselves or they are going to disintegrate. At high wind speeds they shut down.

Q. Fair enough.

A. So if you have wind that is very high, above the cut-off point or below the cut-off point, the average could be quite attractive looking, but really the turbine will not operate much of the time.

All I am trying to say is that wind is a very complex resource. You know that. And to characterize it by a single number is really oversimplifying things.

Q. Of course. Fair enough. Just looking at your map on page 43 of the alternate energy review, will you confirm that none of the numbers shown

on this map show any area of the province that has a commercially viable wind regime?

A. Well, I think you will be asking me to contradict all the discussion we have been saying for the last hour. I don't think this map gives you sufficient information to say whether there is or there isn't.

My testimony is this is a first broad brush, but for those who are serious about this business and can go prospecting they will find areas that have wind regimes better than shown on this map.

Q. Now, an interesting thing you mentioned, you talked about the California wind maps having the little black dots where the very good wind regimes are in some of the passes.

Isn't it true that the mean annual wind speed at the Bruce nuclear station is about 7.13 metres per second, which is about, what, 28, 29 kilometres per hour? And no little black dot there, I just wondered why that would be?

A. Well, I have got to confirm that your number is right, but if you are going to give it to three digits you probably got it out of somewhere that is --

Q. I will even give you the details.

A. Well, accepting that anyway, that chart does not have black dots anywhere. It just shows contours of average speeds.

I think we have spent enough time showing the limitation of that map, and you are giving us proof that, yes, if you look you will find something higher than the average. Average by definition is somewhere that you will find higher wind speeds at certain locations and lower wind speeds at certain locations.

Q. One of the things you haven't mentioned is that generally speaking the AES data - that is, the Atmospheric Environment Service data - is collected at a height of 10 metres; correct?

A. Yes.

Q. Isn't the appropriate height typically for measuring wind speed for wind turbines more like 30 metres?

A. Yes, and I think I mentioned that.

Q. Oh, did you?

A. Yes.

Q. I missed it.

A. With Mr. Greenspoon. I said that airport data is 10 metre height and the more useful readings for wind developments are higher than that.

Q. Of course, at the higher height there

is uniformly a lot more wind resource, isn't there?

A. Yes.

Q. Well, then, now that we have agreed you can't rely on these maps, what are we going to rely on to determine what the wind resource is?

A. Detailed assessments.

Q. You have no data to offer this Board on the raw potential for wind energy in Ontario?

A. Nothing detailed, no.

Q. Well, then...

A. I mentioned in these proceedings that Ontario Hydro is contributing to a resource assessment in the Bruce Peninsula, and I am not sure whether we are contributing to resource assessments elsewhere, but I know that there are detailed assessments elsewhere in the province.

But those are sort of painstakingly made by developers and prospectors and people who want to develop wind form energy.

Q. Well, if you don't have any data, then how did you come up with the number of one to 40 megawatts of wind energy in the next 20 years or whatever it was?

A. Well, that number -- and I indicated that it is just an indication and I indicated where I

came up with that number. It is an Energy, Mines and Resources study that you requested to be tabled in Panel 5, and it is Exhibit 322.12 I think it is.

Q. Yes.

A. That particular study has in it indicated that Ontario under favourable conditions would have something up to -- I think the number is 41.2 megawatts of wind generation in the year 2014. So that is where we got that number.

Q. Is Hydro giving that number as Hydro's evidence or as EMR's evidence?

A. We are giving this as -- you started telling me where you get all the information, and I said we get it from different places. That is one place where we got that particular number, and we adopt it as our evidence.

Q. Okay.

A. In absence of resource studies Energy, Mines and Resources has commissioned consultants - some of them work for Passmore Associates - to do that study, and you are well familiar with that study, and they gave the reasons and they gave the saturation functions and diffusion functions and various other techniques to come up with that kind of number.

But again, it all depends on the quality of the resource assessment that people are working with.

Q. That report that you relied on, that is a draft report, isn't it?

A. Yes.

Q. Isn't it in fact being rewritten specifically with respect to Ontario because EMR wasn't happy with the results?

A. I don't know that for sure. It may well be. But at the time we prepared this we had an access to that report. If it is being rewritten, then perhaps the results will change.

We are not wedded to any of these numbers. You know, if you want to say the potential is not 40 but it is 80 or 100 or 200, I will accept any of that. I think before we go and do some serious site-specific resource assessment any of these studies would have limitations.

My understanding as well is that IPPSO is doing a detailed study of wind resource assessment. I have heard a preliminary indication of the results of that at the wind energy conference in Montreal.

Q. You did?

A. I am eagerly awaiting the results of

that. I think it is being funded by this hearing, and we would love to see what the results look like.

Q. Your number of 40 megawatts could be off by orders of magnitude, couldn't it?

A. It could be off, yes. Orders of magnitude -- you know, I am saying it could be double, triple, maybe ten times, yes. That is an order of magnitude.

Q. Could it be thousands?

A. I am not going to sit here and pretend that it couldn't be. Our best guess is that it isn't going to be that much off, but, hey, we have been wrong before.

I doubt that it is going to be that far off, but if it is, it is not going to happen all of a sudden. I think if it is off by that much that would mean that there is technology to harvest moderate wind speeds; there is acceptance in Ontario. If it is off by thousands, then we are into millions of windmills somewhere. And that will take time to take place.

DR. CONNELL: I believe even one thousand, you are suggesting -- your question would be 40,000 megawatts, Mr. Shepherd? Is that what you are putting...?

MR. SHEPHERD: Sorry, I was asking about

1,000 megawatts as opposed to 40 megawatts.

Q. And thousands of megawatts is not millions of wind turbines, is it, Mr. Shalaby?

MR. SHALABY: A. No. If you said it is off by a factor of a thousand, then it could be millions of turbines, but 1,000 megawatts in California today is about 18,000 turbines, to my knowledge, or something like that.

Q. No, no. 2,000 is 18,000.

A. Is it?

Q. Then, isn't your own evidence that the range of size of wind turbines today is between 300 and 600 kilowatts?

A. Right.

Q. So 1,000 megawatts would be about, what, 2,500 turbines?

A. Of the large variety, yes.

But 1,000 megawatts has happened elsewhere in the world and there is no reason it couldn't happen here. If the wind resource is identified and the land can be made available and all the conditions that made that development viable elsewhere, if they replicate it here there is no reason it couldn't happen here.

But again, when we had to make a judgment

and to make the call we didn't think that that will happen here that quickly. That is the judgment which we had to make.

Now, as more data becomes available and as the technology develops further that judgment can evolve.

Q. The basis of that judgment is that there are not enough windy sites?

A. Well, I think we better consult that exhibit that we mentioned here, the Energy, Mines and Resources data, that has assumptions on both the wind resource but also the rate of return on investments and the acceptance of the technology. It is a complex function of both the acceptance, the rate of return, and the resource itself.

Q. Well, whose judgment are you giving evidence on here, Mr. Shalaby, EMR's or yours?

A. Mine.

Q. So I am asking if you think that there is only a small potential here.

A. Yes.

Q. You made a judgment call that there is not going to be thousands of megawatts.

A. Yes.

Q. It seems to me it can only be because

there is not enough wind, too expensive, or there is some sort of other barrier to the development. I am asking, which is it?

A. Mostly that we are not aware of high wind resources in abundance in Ontario that are close to transmission lines that can be made available to wind developers at low cost. Those three factors are the critical factors.

Q. But you have given evidence already that you haven't done the work to find that out, have you.

A. It is judgment. That is why it is judgment and not an assertion that looking at every cubic metre and square metre on the map we can tell you where the wind resource is.

Q. Maybe your idea of judgment and mine are different. I always thought you exercise judgment on the basis of information.

A. Yes.

Q. But don't have any information on this, do you.

A. We have information. I said, we don't have detailed information of where all the sites are and what the data is. Nobody else has that information either.

We were asked to give potential for a technology with preliminary indication of what the resource is, not detailed information of what that resource is.

If you prefer an answer of we don't know what the wind potential is like, you can have that answer, too.

Q. But that would be the correct answer, wouldn't it?

A. That would be a good answer, yes, but when my management asks me would it be 1,000 or ten or 10,000, I say it is going to be closer to 40 or 50 because they are not going to settle for "we don't know."

But "I don't know" is a good answer; there is no doubt about it.

Q. Do you have any of the preliminary information from the people doing detailed studies on Lake Huron and in the Sudbury area? Is any of that information available to you yet?

A. Not to me.

Q. Well, the "you" meant "Ontario Hydro".

A. If it is available to other places in Hydro I am not aware of it.

Q. You are not aware of it? Okay.

A. But I know there are detailed assessments being done in the Sudbury area.

Q. Maybe this is part of that same question, but I will ask anyway. Are you aware of a specific developer that has advised Ontario Hydro of a site with 100 megawatts of potential that is readily available today?

A. Yes, I am.

Q. Do you disagree that that site has 100 megawatts of potential?

A. I have no reason to disagree.

Q. Well, but isn't 100 megawatts in that one site bigger than your 40 megawatt judgment?

A. Yes. And if that site gets developed to that size then our judgment will have been wrong, wouldn't it?

Q. Okay. Could you turn to Volume 109 of the transcript.

A. I just want to say that those kinds of proposals and assessments, we have seen those before and we continue to see them, and we are not wedded to any one number and if developments take place then we will just modify our expectation.

Q. But the proposal you are talking

about -- I am not going to mention names obviously, but the proposal you are talking about --

[11:15 a.m.]

A. This is going to be a private discussion? Just you and I know who we are talking about. I don't think that's very helpful to the Board.

Q. I am going to ask you to characterize it, it's from an experienced wind power developer that knows what they are doing; is that correct?

A. Yes, absolutely.

Q. It's not some person who thinks wind power is a good idea. It's a big company.

A. They think it's a good idea too, but it's a big company, yes.

I have to go back and not leave this question of our estimates of potential. It was a very difficult job for the team that we have put together, the team that wrote that report, a very difficult question to ask them to cough up a potential by the next 20 years. It's a very difficult job to speculate as to what people will find when they go prospecting.

If we go back to the geological survey and finding gold, if you send people prospecting how could you predict how much gold they are going to find? It's very difficult to estimate that.

So it's a number that's difficult to estimate, however, people have to make judgments. Mr. Smith, for example, would rely on projections of natural gas, not based on identifying every well and every geological information but on experience. This reserve and unproven reserve and all of that is just based on judgment.

So the application of judgment to what you think the reserve will be or what the potential will be is a common thing to rely on in our studies. But it's got the uncertainties associated with it.

I think the other factor that we haven't seen in wind developments in Ontario in a big way could, for example, support the idea that we don't have the abundant resource that perhaps California does.

Although I enjoy those Group of Seven paintings that have the pine tree tilting to one way, that is a sign of strong winds for a long period of time, but all along the Georgian Bay you can see those trees and you know there is a been wind in the area. But is that a suitable resource or not is a complex question to answer.

Q. What we have been talking about though, and I am not trying to criticize what your people have done, I guess what we are asking is, how

much reliability, how much faith should the Board put in the number that you came up with? Do I get the impression that you are saying that the reliability of your wind resource estimate is comparable to the reliability of gas reserve estimates?

A. No, I am just explaining to you the hazards and the uncertainties associates with predicting resources that you haven't scouted for in detail into the future. It's that kind of nature.

Q. I understand that. My question was a yes/no question.

Is it your evidence that the reliability of your wind resource information is comparable to the reliability of your natural gas resource information?

A. I would think it's even less reliable.

Q. Fair enough.

If you could look at Volume 109, page 19123. I have got to find the line number here.

In line 8 through 10 you are talking about availability of land for wind developments, you say: I don't know to what extent those lands, this is lands on the Great Lakes, would be available for wind farm developments.

I guess I would just ask you to elaborate

briefly on that?

A. Elaborate?

Q. Elaborate briefly on that.

A. Well, I think what it says is that while there may be windy sites on the Great Lakes, on the shores of the Great Lakes, I do not know whether these lands are publicly-owned or privately-owned, whoever owns them, whether they would release them for wind farm developments or not, whether the public and the environmental approval process in the province would permit the siting of wind farms on the shores of the Great Lakes in these locations. There are uses for these lands, whether it's recreational or tourism, or some of them are reserves and so on. That's what I meant by I don't know whether this land is available to wind farm developers or not.

Q. So that's not different from the uncertainties surrounding siting a nuclear station; is it?

A. No, it's not.

Q. Except it's probably fair to say that a wind farm has less local resistance than a nuclear station; is that fair?

A. I will accept that, yes.

Q. Wind farms have co-existed

successful --

A. Mind you, until you try and do it. Things are terribly acceptable until you try and do it.

Q. Okay. Wind farms have co-existed successfully with agricultural operations in numerous places; haven't they?

A. The places I have seen and read about, I guess if you take Holland, wind farms are in nice harmony with agricultural uses.

In California the lands are not high grade agricultural, but they are in co-existence with grazing and other activities, yes.

Q. Altamont Pass in California is the largest concentration of wind turbines in the world; right?

A. I think so, yes.

Q. There is about 4,200 wind turbines there?

A. I will take your number. It's not unreasonable.

Q. It's 800 megawatts or something like that; correct?

A. That's about right.

And again, I should get my copy of Exhibit 409, it describes the wind resource in

California and where it's located in the mountain passes and what type of machines and everything else in there.

Q. It's okay. These are just set up questions. All of that land --

A. The kill comes later, does it? [Laughter]. This is set up. That is fine.

Q. All that of land is used for cattle grazing; correct, the Altamont land?

A. I don't know whether it's all or not, I don't know. But to my information there is no reason it couldn't be. Much of the land could be used for cattle grazing, whether it's all being used that way or not, I don't know.

Q. Mr. Shalaby, have you ever seen a wind farm?

A. Yes.

Q. Where?

A. In Altamont and Tahachapi and in San Gorgonio. I have been to all three mountain passes.

Q. So you have seen the cattle grazing on the hills at Altamont; haven't you?

A. But I haven't seen them -- my answer is not all. I haven't seen all 4,200 and 800 megawatts with cattle below every one of them. [Laughter]

Q. Fair enough.

Isn't it true that the advent of large scale wind energy development in the Altamont area saved the economic position of the farmers in the area, that is, they were in touch economic times and the reliable income from the developers saved their farms; isn't that true?

A. I know that in the places where wind farming took place, it's been welcome news by the locals. Now I don't know whether it made the difference between bankruptcy for the farmers or not, but it's been welcome news, yes.

Q. Most of the eastern shore of Lake Huron, the area where Bruce, for example, is, it's largely agricultural area; isn't it?

A. Yes.

Q. Sheep farming, some dairy farming, things like that?

A. I wish Mr. Thompson was here, he would give us a bigger breakdown, great detail of what the farming types are. I am not familiar exactly what the types are, but I am presume that is also set up.

Q. So it's fair to say, isn't it, that just on a preliminary basis, sort of as preliminary as your wind speed map perhaps, that there is probably

some opportunity there to place wind turbines in agricultural areas?

A. Yes.

Q. We shouldn't be really concerned that the landowners are going to resist and say no wind turbines in this area?

A. I have testified here that we know of a particular landowner that is actively soliciting wind turbine development on his land in the Bruce area.

Q. Oh, really. That's good.

And similarly the Sudbury area -- I'm sorry.

A. Mr. Burpee was reminding that Mrs. Mackesy might have been concerned about wind developments on different farm lands, but I said that your question was whether the owners would be concerned, and I thought not.

Q. The Sudbury area also has lots of available land for wind development; doesn't it?

A. My understanding is yes.

Q. As with the Bruce area, the Sudbury area could certainly welcome the economic development associated with large scale wind energy; wouldn't that be true?

A. I assume so, yes.

MR. SHEPHERD: Mr. Chairman, I am moving on to a different area, I wonder if this might be the be the appropriate time to take the break.

THE CHAIRMAN: All right. We will take fifteen minutes.

THE REGISTRAR: The hearing will take a 15-minute break. Please come to order.

---Recess at 11:30 a.m.

---On resuming at 11:45 a.m.

THE REGISTRAR: Please come onto order. This hearing is again in session. Please be seated.

THE CHAIRMAN: Mr. Shepherd?

MR. SHEPHERD: Thank you, Mr. Chairman.

Q. Mr. Shalaby, we are still in wind energy. I would like to turn to the size of developments that you have modelled.

You have used as you are examples in the ought ever alternate energy review a 10 kilowatt distributed application, which I will ignore for the time being, and a 7 megawatt grid connected development; right?

MR. SHALABY: A. Yes.

Q. It's correct that utility scale wind farms being developed today are - except for demonstration projects such as the ones in Alberta -

all larger than 7 megawatts; aren't they?

A. Generally in California the wind farms are larger than 7, yes.

Q. Looking just at the cost of the turbines themselves, I will get to the rest of it in a second, would you say that generally as the size of a wind farm development increases. The cost of the turbines per kilowatt increases, decreases or stays the same?

A. I presume it could decrease. The quantity purchase could cause a decrease in the price. But again, it's specific as to who is supplying the turbines and things like that. But generally the more you buy generally you can get a better price.

Q. Can you explain to the Board the concept of balance of system, BoS, as a component of wind farm development, what is that concept?

A. That is the components like transformers, power conditioners. In the case of variable speed wind turbines it would be inverters, converters, to convert the energy from direct current to alternating current. That's what balance of system means.

Q. It includes also the roads on the site and the transmission lines on the site, that sort

of stuff?

A. I am not sure whether we call that balance of system or whether we call that services to the site. But yes, the development includes road preparation and site preparation.

Q. All of those other costs are, on average, around 25 per cent of the cost of a wind farm development typically?

A. I don't know that for a fact. Again, it depends on how remote the site is or how difficult it is to harness.

Q. Typically, balance of system costs or the costs in excess of the wind turbines themselves, they will tend to decrease per kilowatt as the size of the development increases; isn't that correct?

A. Yes.

Q. So, just looking at the capital costs side, isn't it fair to say that virtually all of the capital costs are going to be lower per kilowatt as you look at larger scale wind farms?

A. I accept that, yes.

Q. On the operating side, as I understand the alternate energy review, you have modelled a 7 megawatt wind farm as needing either three or four full-time staff depending on how you look at

it; is that correct?

A. I'm not sure of that particular number. If it's in the review, it might be correct.

Q. Didn't the alternate energy review say that the reason you chose 7 megawatts was because that was a three-person team, that represented 20 or 25 machines and therefore was a three-person team?

A. It says the experience shows that a single maintenance crew, mechanical, electric and electronic technician can serve 20 to 25 machines. This is therefore considered minimum for commercial operation.

Whether the crew is three people or includes these three skills, I don't know. But three people is not unreasonable to maintain a farm like that.

Q. But there must be a number you used when you did your calculations; isn't there?

A. Yes.

Q. What was it?

A. I don't know it for sure. But I can find out if it is important.

Q. It's true, isn't it, that the largest wind power developer in the world Kenetech runs 4,000 machines with a staff of about 80; isn't that right?

THE CHAIRMAN: How many did you say?

MR. SHEPHERD: Eight-zero.

MR. SHALABY: I don't know that for a fact but I wouldn't be surprised.

MR. SHEPHERD: Q. Isn't it correct that the new wind farms being planned at the sort of 100 megawatt size in various places around the world are contemplating a staff of five?

MR. SHALABY: A. Again, I don't know that for a fact. But as machines become more reliable and as they are remotely controlled and remotely operated, the number of staff necessary to operate them can reduce.

Q. Is it fair to say, isn't it, that the larger wind farm will generally have lower operating costs per kilowatthour, won't they?

A. Than smaller ones?

Q. Than smaller ones.

A. Yes.

Q. On that same page 55 of the alternate energy review that you were just looking at, the same paragraph, page 55 of Exhibit 344, paragraph .4 on the right-hand column, it starts off: "Why select 20 units", and if you go down it says:

Because Ontario Hydro does not have

specific sites with very high wind speeds, Ontario is not likely to follow California's pattern of very large wind farms.

Now given our conversation earlier, is that statement correct, to your knowledge?

A. Well, part of the statement that the Danish pattern of small groupings, that there is a pattern of small groupings in Denmark, and larger groupings in the United States, that is correct.

The statement says it's not likely to follow the California pattern, that's an opinion by the authors of this report that the likely development is not likely to be large farms but perhaps smaller groupings. That was a judgment made here.

Q. The reason given, is we don't have specific sites with very high wind speeds; right?

A. Yes.

Q. But that's not something you know; is it?

A. Well again, we went through the idea that the indications are that we are not a windy province on average in general. Perhaps there are specific sites that are windy.

So maybe if you have a specific site that

is windy, that is large, you could have a large development. But in general, unless you have many large sites that are windy, then a more localized development is more likely than widespread several thousand turbines per development is more likely. That is a judgment made by the authors.

Q. It is true that the proposals that have been made to Ontario Hydro so far for wind farm development have generally been much larger than 7 megawatts; right? One was 100 -- in fact, there have been a couple at 100; haven't there?

A. I don't know the exact details, whether there are a couple or one, or whether they have been proposals or just discussions, I don't know the nature of the exact proposals from the wind developers to Ontario Hydro.

Q. Isn't it true that in Hydro's discussions with wind farm developers, the developers have been telling you, we can't do small projects, we can only do large ones because it's not economic to do small ones?

A. The big developers prefer to do big projects.

[11:56 a.m.]

There may be smaller developers that are

more comfortable with smaller projects, I don't know that, but the big developers certainly find the economies of a large farm to be attractive.

DR. CONNELL: If I could just pause for a moment and go back to this issue of employment.

The case you cited, Mr. Shepherd, was 4,000 machines and a staff of 80?

MR. SHEPHERD: Yes.

DR. CONNELL: The employer in that case was...?

MR. SHEPHERD: Kenetech.

DR. CONNELL: Kenetech. Can I infer for purposes of discussion, are they involved in Altamont?

MR. SHEPHERD: Altamont and Tehachapi and San Gorgonio, and I think they have some actually in Whiskey Run in Oregon as well.

DR. CONNELL: So that is comparable to the 4,200 turbines at Altamont which generate 800 megawatts?

MR. SHEPHERD: That's about right, yes.

DR. CONNELL: Can we assume that these 4,000 machines/staff of 80, for the purposes of discussion is approximately 800 megawatts?

MR. SHEPHERD: I believe it is actually a little more than 800 megawatts, but it is in that

range. Yes, sir.

DR. CONNELL: Okay. Now, if we assume -- what ACFs is it reasonable to assume for one of these?

MR. SHALABY: 20 per cent, 25 per cent.

DR. CONNELL: So we are looking at about a terawatthour order of magnitude, one to two terawatthours per year?

MR. SHALABY: That is about right, yes.

DR. CONNELL: If I could take us back to 505, then, a terawatthour, direct employment per terawatthour per year is 542. That is a lot bigger number than the 80.

MR. SHEPHERD: Yes.

DR. CONNELL: For comparison, I wonder, could we think of a fossil plant that is approximately 1,000. Is that you, Mr. Burpee? 1,000 megawatts?

MR. BURPEE: I'm sorry, I didn't --

MR. SHALABY: Employment for a 1,000 megawatt fossil plant.

MR. BURPEE: Well, Lakeview which is 2,400 is about 600 people. Nanticoke is probably about 650 for 4,000 megawatts.

So for our standard 500 megawatt unit you are probably looking at, including common services, 120 people per pair of units.

DR. CONNELL: For two 500 units?

MR. BURPEE: For two 500 megawatt units, yes.

DR. CONNELL: 120 people?

MR. BURPEE: Yes.

DR. CONNELL: Perhaps Exhibit 505 was talking about other kinds of employment, then, or perhaps it was using earlier data than the numbers Mr. Shepherd cited for Kenetech.

Thank you.

MR. SHEPHERD: Q. The numbers you are talking about there are simply operating and maintenance staff, right; they don't include any of the construction, manufacturing or anything like that? Correct?

MR. BURPEE: A. No. No.

Q. Mr. Shalaby, given your evidence that wind farm developers, the larger developers tend to prefer larger sites, larger-sized developments, why would you model 7 megawatts rather than 70 or 100 or whatever sort of range is more common in the industry today?

MR. SHALABY: A. I think we have seen the Canadian wind farms to be in the 7 or 9 or 10 megawatts: the Alberta, for example, Pincher Creek

developments.

Q. Those are demonstration projects, aren't they?

A. Yes.

Q. Are demonstration projects generally done at the same size as commercial scale projects?

A. Well, I think I am coming to the point of you learn to walk before you learn to run, kind of thing. If we are going from a single unit 10 kilowatt or 100 kilowatts perhaps an intermediate step to the very large size wind farm could be an intermediate size farm for demonstration projects.

Q. When Ontario Hydro modelled the integrated coal gasification combined cycle to see whether it was a cost effective solution in Ontario did it model demonstration project-size developments or did it model a full-scale development?

MR. DAWSON: A. It modelled multiple modules of a full-scale development.

Q. You didn't do that for wind energy, did you?

MR. SHALABY: A. I think one of the benefits wind energy offers is that it is module and the economies of scale may not be as pronounced as for other plants, for example. There may be economies of

scale. I don't know whether it invalidates the results for a smaller development or not.

Q. Yes, Mr. Dawson. Sorry?

MR. DAWSON: A. I was just going to add that the demonstration typically would also be at full scale. Otherwise, it is not a demonstration.

Q. So your belief is that demonstration projects typically are full size?

A. EPRI, for instance, had a cool water demonstration modelled, a single module that was full scale, yes.

Q. I don't follow. Could you expand on that?

A. They are saying that if you are going to demonstrate it, if you don't demonstrate it at something that is close to full scale anyway then there is not a lot of value in the demonstration. So demonstrations do tend to be at what you would call commercial scale.

Q. Well, Mr. Shalaby, you just answered that question differently and you just said, as I understood it, that demonstration projects tend to be smaller than commercial scale projects.

MR. SHALABY: A. Yes.

Q. Do you wish to change that?

A. For modular developments whether you put twenty 350 kilowatt machines or you put 200 of them you are demonstrating the same piece of technology.

Q. But your cost is going to be different. Isn't that what you --

A. The cost could be different. And I would like to draw your attention to page 61 of Exhibit 344--

Q. Yes?

A. --to show you that we have done sensitivity work on OM&A, perhaps to capture the size of the farm that you are mentioning. We are showing that if OM&A for option 2 -- I am looking at table 2-10-7, which is the top table.

Q. Yes?

A. The third line in there, which is option 2, "1991 Costs", we are saying that the point estimate for operation, maintenance and administration is 1.4 cents per kilowatthour.

We investigated the sensitivity of the cost to a reduction of 20 per cent of that operations, maintenance and cost. So we can detect from that what effect a reduction in OM&A might have on the viability of the wind farm.

So I think that range is given here to

explore things like perhaps there are economies in a larger installation or perhaps there are improvements in maintenance practice and proven reliability and so on.

Q. So your evidence then is that this sensitivity analysis captures the impacts of larger scale developments?

A. Maybe not fully, but it shows what a 20 per cent reduction in OM&A would do to the viability or to the net present value of cost.

Q. Okay.

A. Now, whether a large scale development is 20 per cent lower in OM&A or 50 per cent lower in OM&A I don't have that information. I don't know.

Q. Could you turn back two pages in the alternate energy review to page 59?

A. Before we leave that, I think the 1.4 cents per kilowatthour is comparable to the figure that you tabled in Exhibit 493 as a first glance at 1-point-something cents per kilowatthour maintenance.

Q. I am going to come back to that. We will talk about that in a minute.

A. I am just saying that the 1.4 is a number that is adopted for large wind farms, not for

small experimental wind farms. So 1.4 is a good number. I am quite comfortable with it.

Q. Good. In figure 2.10.4 on page 59 of Exhibit 344 you have listed initial capital costs there for option 2, 10 megawatt -- sorry, the 7 megawatt wind farm of $1,740 per kilowatt; correct?

A. Yes.

Q. On what information did you base that estimate?

A. On data available from large manufacturers and from the sources that we cite at the end of that chapter, and we have noted in our discussion that now cost estimates have gone down from that.

Q. This alternate energy review was done in September of 1991; right?

A. That is correct.

Q. Now, that $1,740 per installed kilowatt, that is complete turnkey cost; right? That is everything, all the capital costs; correct?

A. Yes.

Q. Okay. Is it fair to say that that is roughly $1,480 a kilowatt in U.S. dollars?

A. Sounds good.

Q. Okay. Is it also fair to say that

economics of a wind farm are very sensitive to initial capital costs?

A. Yes.

Q. Looks to me in fact like initial capital costs are in a range of 75 per cent of the total net present value of a wind farm?

A. That is reasonable, yes.

Q. Okay. That is generally true of most renewable energy technologies, isn't it?

A. Yes.

Q. That they tend to be very capital intensive?

A. That is correct.

Q. Because you don't have the fuel cost; is that right?

A. Yes.

Q. Could you turn to Exhibit 493 which you just mentioned and look at page E6-2? I think the reason they number it that way is because it is so long they don't want to have page 1,000 in a report.

If you take a look at page E6-2--

A. Yes.

Q. --would you confirm that the California Energy Commission's analysis of the capital cost of a wind farm per kilowatt is $781 U.S. which, if

you escalate it from '89 dollars to '91 dollars is approximately $870?

A. But if you convert it to Canadian, what would that be?

Q. I have already converted the Canadian to U.S., $1,480; right?

A. Oh, you converted the other one, yes. Yes, that is what is written on page E6-2.

Q. It is correct, isn't it, that their estimate is a directly comparable number, isn't it? They are saying this is an all-in cost; isn't it?

A. It is intended to be that, yes.

Q. So by my calculation your assumption is about 70 per cent higher than theirs. Why is that?

A. Well, if you go on and read E6-2, the paragraph that you are pointing us to, it says that until recently the cost estimates were over $1,000, $1,800 or something in that nature.

Q. Sorry, is that what it says?

A. Well, recently the estimates have come down considerably.

Q. Yes, that is fair.

A. And recently, as recently as a phone call, I think the reference to the 781 is a phone call to U.S. Wind Power, reference 6. Am I correct?

Q. Yes.

A. It says there it is a meeting and a phone conversation with Eric Miller of U.S. Wind Power on July 2nd, September 30th, 1991.

So that estimate is based on a quote from U.S. Wind Power, which is the largest manufacturer of wind turbines in the States, to my knowledge; recent information, a quote from a manufacturer. That is the basis of that quote.

My information is that this is a recent development in U.S. Wind Power's marketing of these turbines. So that is the reason for the difference. I am coming to your question of why is it that we are adopting 1,400 and they are adopting something like 800 or 900. There has been a recent reduction in estimates by that one manufacturer.

Q. So when we look at your alternate energy review should we then mentally reduce your capital cost assumption to something more like what the CEC has?

A. Depending on the confidence you would place on that lower cost estimate. If you accept it with confidence, then you could do that.

Q. No, I am asking for your evidence on that. You said this is more recent information. Is it

as reliable as your information?

A. Well, I think I would like to -- I heard it from those manufacturers as well but not from other manufacturers. They have confidence in delivering equipment at that price. To my knowledge, they have not done that yet with anybody. They haven't delivered the equipment at that price to any utility or any developer, and I think one would develop more confidence when we see equipment delivered and installed for that price.

Q. So for planning purposes is it appropriate to use $1,480 a kilowatt U.S. or is it appropriate to use $870 a kilowatt U.S., or somewhere in between?

A. We have done sensitivity analysis that would indicate that if costs go down by 10 per cent, the capital cost goes down by 10 per cent, the net present cost would go down by 8 per cent, fairly close to 1 to 1.

So, if costs go down by 40 per cent, as in this case, then the net present costs of a wind farm development would go down substantially and the cost/benefit ratio would be favourable, would be close to 1 or even less than 1.

Now, whether one would use the lower

number for planning purposes or the higher number for planning purposes really depends on the confidence and validity of that lower dollar per kilowatt number that is only a few months old and is only a phone call from a manufacturer.

Now, it may well be the case that they are tooling up to develop products at that price, and if that is the case then the costs will come down in Ontario as well.

Q. Well, this is not a new product that has never been delivered before, is it. They are up and running in places, aren't they?

A. No, my understanding, this product is a variable speed machine that has not been delivered to any utility yet.

Q. But they are up and running in Altamont, aren't they? I mean, I saw them, Mr. Shalaby.

A. They have two machines on their own site. The manufacturer has two machines on their own site. They are testing them there, yes. But they haven't made a sale of thousands of these to anybody else.

Q. It is true, isn't it, that Pacific Gas & Electric has listed a 100 megawatt wind farm

using these machines at this price as its deferrable resource, as its proxy plant, in recent public utility commission hearings in California; isn't that correct?

A. That is correct.

Q. So they obviously have some confidence in them?

A. For the purpose they used it at. This is not confidence to invest in it or to put their money on it yet. It is just for the purpose of identifying the deferral resource that they felt it appropriate to put that resource in.

MR. SHEPHERD: I would like to file a new interrogatory, which is 7.14.21. Copies have been provided, Mr. Chairman.

THE REGISTRAR: 7.14.21 is .33.

---EXHIBIT NO. 475.33: Interrogatory No. 7.14.21.

MR. SHEPHERD: Q. Now, Mr. Shalaby, if I am not mistaken, this is a March, 1989 internal report by Ontario Hydro's most experienced wind energy expert; is that correct?

MR. SHALABY: A. Yes.

Q. And the report is actually on the Fort Severn project; right?

A. That is right.

[12:15 a.m.]

Q. I would like you to turn to page 11, if you would, please. In the sixth paragraph the report talks about the capital cost of the turbine that was put up in Fort Severn. That turbine, by the way, is no longer manufactured anywhere in the world; is it?

A. I don't know that. But you may be right. I don't know.

Q. In that paragraph the last sentence is, and this is 1989 now: Other wind turbines may now be available in $600 to $1,000 per kilowatt range.

So, why would your own wind energy expert be using as an example numbers so much lower, in 1989, so much lower than the numbers and you are assuming today?

A. I could only tell you that it's the same experts that put together the more recent estimates.

The purpose, as I explained to you, for putting together Exhibit 344 is to make sure that all the cost components are accounted for on a consistent basis in the same dollars, in the same rating and so on.

Now I don't know exactly what page 11 is referring to, but all I can tell you is it's the same experts that put this together, put the other one

together, and on a more consistent and more complete basis.

Q. Okay. But you have said, haven't you, that if your capital cost numbers are wrong, if the CEC numbers were correct, then wind power today would be at roughly 1.0 cost/benefit analysis; right?

A. At a good wind site in Ontario, yes. Sudbury kind of conditions, yes.

Q. So - correct me if I am wrong - that would have been a big effect on your projections for the role of wind power in electricity planning; wouldn't it?

A. Yes, it would.

Q. Just before I leave that --

A. Again, not to be repetitive, but it is (A) that the costs of the equipment installed in Canada is in $700 to $800 range and, (B), there is sufficient land that is good wind resource, close to transmission available for development. Get enough of that together and you have good potential, yes.

Q. But on the information to date you know there are sites that have appropriate wind regimes; correct?

A. Yes, we do.

Q. And you know that there are

manufacturers prepared to deliver at cost-effective prices, yes?

A. I don't know that for a fact. These are discussions that I hear, but until contracts are produced and people are prepared to deliver at specific prices, I guess nobody else will know.

Q. Now, of course, for planning purposes your projected prices are more important than your current prices; aren't they?

A. That's right.

Q. Your projected capital costs for the year 2000 for wind is - this is also on page 59 of Exhibit 344 - your projected price is $1,490 Canadian in 1991 dollars; right?

A. That's right, yes.

Q. In the same reference in the California Energy Commission, isn't it correct that they are talking about the current -- the next generation, the new machines coming out now are projected to cost as low as $600 a kilowatt? Same page, same paragraph.

A. Yes. And the reference to that is information presented at the American Wind Energy Association Annual Conference. It doesn't give specifics as to who is giving that information or in

what context, and so on. But yes, that's what is written in here.

Q. Isn't it correct, Mr. Shalaby, that the consensus of the utilities and government officials and wind energy experts and manufacturers in the United States is that the year 2000 number to plan on is $600 a kilowatt? Isn't that the number that they have all been using for the last six months?

A. Consensus is a big word for utilities and regulators and energy departments. I don't think they ever reached any consensus on anything. But if it is a number that people have been using in increasing numbers, I'm not aware of that.

Q. You have been in contact with the other people involved in wind energy in North America; haven't you?

A. But I can't say that I know what the consensus is. I know that people who are following the wind energy developments and have confidence in technical developments that will take place, manufacturing cost studying will take place, might feel comfortable planning on a number like that. But I wouldn't say it's a consensus. Not to my knowledge. If you know any different, that's something different.

Q. It's your evidence, not mine.

When you published your figure of $1,490 in capital costs for the year 2000, did you talk to any of the people working in the area in the United States to see whether that was a reasonable projection?

A. I think the references indicate the references to that chapter. They start on page 63 and go on on page 64, indicate the extent of contact with various utilities and various research organizations in the United States and in Canada. I think it's a safe bet that we would be in touch with people elsewhere in the energy business, in the wind business.

Q. So is the answer to my question yes or no?

A. The answer is yes.

Yes, we have been in touch with some people, whether they are all the people or not, it's unlikely that it is all the people doing wind work, but a representative sample that we feel would give us confidence in the numbers that we have.

Q. Would you confirm that if the number used by the California Energy Commission of $600 a kilowatt were correct that wind energy in Ontario is cheaper than many of your other options on a planning basis obviously?

A. I think I have got to qualify that

again with, provided there is land available at costs that are reasonable and close to transmission.

It's not such a trivial issue. You are shaking your head as if it's trivial issue. It isn't.

Transmission can make or break a wind farm development. Land costs can make or break a wind farm development, and wind speed distribution that is slightly off from good conditions can make or break a wind farm development. So you have to have all these things lined up for that kind of statement to be made. And if they line up, yes, wind energy would be a viable alternative for Ontario.

Q. We are not talking about 40 megawatts here, are we? If there is available land and there is available wind at these short of costs that are being used by the California Energy Commission, we could be talking about thousands of megawatts; couldn't we?

A. If there is available land with all the provisos, yes.

Q. Yes.

A. But I think Dr. Effer and myself gave the evidence that perhaps the transmission network can accommodate a 40 megawatt or 30 megawatt wind farm, several thousand megawatts would have significant implications on transmission capability requirements,

significant implications on reliability reserve that's required to backup the wind resource that's intermittent, many of those effects are not very well understood either.

So I am just saying that the first little bit we can safely say we absorb on our system without very much penalties or disturbance to the existing system. When we let our imagination go to a much larger penetration of wind, we don't know all the answers as to the impact on transmission, on reliability reserves, on the use of other resources and so on. It will have impact on the fossil system, hydraulic system, everything else.

Q. It is true that there is almost 2,000 megawatts in a California; correct? 1,850 or something?

A. It changes every day, but that's about right.

Q. And except for transmission limitations in Tehachapi because the lines aren't there, have there been system problems with adding that wind to the system?

A. Not to my knowledge. But we have to understand that the California electricity system is larger than Ontario's and that the resources in

California are different than the resources in Ontario. There are differences. But up to there, not to my knowledge, there aren't significant problems, no.

Q. One other question about capital costs, just take a look at your sensitivities here. Your sensitivities on capital costs are -- this is on page 61 of Exhibit 344. You have done an analysis for 1991 cost of plus 21 per cent and minus 20 per cent, and you have done an analysis on the year of 2000 costs of plus 20 per cent and minus 10 per cent. The distribution you are modelling in 1991, that is a symmetrical distribution; correct?

A. Yes.

Q. The distribution you are modelling in the year 2000 is an asymmetrical distribution with an anticipation of more likely higher costs than lower costs; correct?

A. That's right.

Q. When you have a developing technology isn't it true that the typical cost distribution in future costs is asymmetrical on the lower side rather than the upper side; isn't that correct?

A. I don't think I can accept that for any developing technologies. Many developing technologies, as they develop you find higher cost

components coming in or problems that you haven't anticipated.

I don't want to give a yes or generalize that any developing technology goes down in price, that is not necessarily the case.

For wind the technology has been coming down in price significantly over the last 10 years, and the judgment of the people that put this report together is that they are projecting aggressive reductions from today's prices to the year 2000 prices, and they felt there is a chance that the price could be lower and there is a chance that the price could be higher. They are more comfortable with an asymmetrical distribution.

Q. And why would that be?

A. Their feeling that there may be a likelihood, a higher likelihood of the price being higher than lower.

But I don't think that is explicitly mentioned here, that this is in fact the distribution that describes their confidence in prices. It's implicit in there that they think there is a smaller chance of being below that price than above that price.

Q. Now of course when Hydro models costs for fossil or nuclear, in fact you use a symmetrical

distribution, don't you?

A. Not for all components, no.

Q. Overall isn't your cost analysis that you provided to this Board for nuclear, for example, doesn't it present a symmetrical distribution of capital costs?

A. Maybe we will leave something for Panel 9 to talk bout. But my understanding is that the pluses and minuses on various components is not necessarily symmetrical.

Q. Is it fair too say, Mr. Shalaby, that when you are looking at costs, capital costs, say, that you look at the costs and the sensitivities of costs differently if you have to actually make a decision whether to do something or not, or whether you are making a planning judgment as to which direction to go in? You look at costs differently?

A. Generally there is more rigorous assessment of risks and costs when it's time to commit to a project than it is when it's time to project its potential into the future, yes, quite right.

Q. And when you are making a commitment, for example, isn't there an emphasis on, in effect, getting the right number without being as concerned about the symmetry of the distribution?

A. Yes.

Q. So, for example, your median cost of nuclear and your median cost of wind today showed that wind was higher, but the cost distribution showed that there was much more likelihood that wind would be on the low side than on the high side and vice-versa for nuclear, then from a commitment point of view you would chose nuclear, but from a planning point of view you might chose differently; isn't that correct?

A. All I am saying is the criteria used at the time of committing projects is risk assessments and sensitivity studies that are more detailed than what you see here. Scenarios of what happens if this happens or that happens, our performance falls short, our life is longer or shorter.

If what you are asking implies that there is no weight given to variations around the mean, I will have to reject that proposal. We do give probabilities around the mean number.

But what I accepted earlier is that when you are making the commitment to something you are trying to find its costs as best as you can, recognizing all along you may be wrong one way or the other.

Q. Okay. I am not going to go through

your other assumptions in detail, but I do want to ask a couple of questions about a couple of things.

Can you turn to page 57 of Exhibit 344. If you look at paragraph .2 on the left-hand column, it is 2-10-1.2, I guess, your assumption of the life of a wind development is 25 years; correct?

A. That's what it shows there, yes.

Q. And if you look at the California Energy Commission at page E6-3, it's correct that they have assumed a 30-year design life; correct?

A. They may well have, yes. Yes, they have.

I think I indicated in my direct evidence that the practicality of the matter is that wind turbines have parts of them replaced continuously. The blades get replaced, the brakes are replaced, the generator is replaced, and so on. The concept of a definitive life where you don't touch the machine and then throw it away at the end of its life is really oversimplifying what really takes place in the wind farm.

Q. That's true of a fossil facility, too, isn't it?

A. It is, yes.

Q. But you still make an assumption as

to how long it's going to last?

A. That's correct.

Q. And you have just increased your assumption of how long your current stations are going to last; right? Haven't you just told us that you are going to extend the life of the fossil station so they are not longer 40 years, they are 50 or 70 or whatever.

A. Yes, for two of the stations, yes.

I'm sorry, I heard a decrease and I think you said increase.

Q. Isn't it true generally that for technologies such us a wind and solar, perhaps even fuel cells and others, that Hydro's assumptions as to life tend to be shorter than other jurisdictions such as California, whereas for conventional technology such as nuclear and fossil, your assumptions as to life tend to be longer than other jurisdictions; isn't that a correct generalization?

A. I don't think it is, no.

I think photovoltaics, we are assuming a life that's similar to what is in the California Energy Commission report, so that immediately says that we are not necessarily assuming a shorter life. Other members of the panel gave evidence that some other utilities are assuming lives that are comparable to our fossil

generating facilities.

Q. I didn't hear that evidence. Who was that, Mr. Meehan?

MR. MEEHAN: A. Sorry, was there a question?

Q. Mr. Shalaby was saying that there are other utilities that have fossil fuel life assumptions that are as long as Hydro's, as Hydro's new ones.

A. I think there might be. I think in your own exhibit here, Exhibit 493, on page E8-1, it talks about electric utility boilers in the first paragraph nearing the end of their nominal design life of 30 to 40 years, should be a evaluated as candidates, and it goes on later the page to suggest under what they are calling life extension and life enhancement. I believe in there somewhere I saw a 30-year life extension--

Q. On the next page?

A. --was what was mentioned.

So, I don't think the concept that's being looked at here is very much different from what we are looking at for Lambton and Nanticoke.

Q. I am not suggesting that for a moment. What I am asking is -- perhaps I could put it to you this way: Can you think of a circumstance, Mr.

Shalaby or Mr. Meehan, in which Hydro's assumption as to the life of any station that it currently has, any conventional station, is shorter than a comparable station with any other utility in the world, first?

A. I have limited knowledge on what other utilities in the world are assuming.

Q. Mr. Shalaby, this must be something you have looked at for system planning purposes.

MR. SHALABY: A. The question again is whether Hydro is...

Q. Whether Hydro's assumption of the life, the plant life of any of its existing stations is shorter than the assumption of plant life of any other utility for a similar station anywhere in the world?

A. What you are asking is whether we are on one side and everybody is assuming a longer life? Is that what you are saying?

Q. No. I am asking, do you have -- for example, your assumption for nuclear stations is 40 years, is there any utility that assumes a longer life than that in the world?

A. I don't have that knowledge, I don't know.

MR. BURPEE: A. For fossil though we do have utilities that assume a longer life. We have only

put in the plan to extend two of the Unit 2 stations, which leaves, say, Lakeview at 40 years, and I know that Duke Power, Texas Utilities and even Niagara Mohawk have the same vintage where they are planning them longer than 40 years.

Q. And they have changed their plant life assumptions for coal?

[12:36 p.m.]

A. For coal.

Q. To longer periods?

A. Yes.

Q. Much like your Nanticoke and Lambton assumptions?

A. That's correct.

Q. Fair enough.

MR. SHALABY: A. But coming back to what I presume is the relevant question to the wind as we were discussing--

Q. Yes?

A. --the experience has been that the equipment is being replaced continuously, blades are being replaced because they have better designed blades. It is almost safe to say that no machine in California today is the original machine that was put on the site. Probably most of them have been upgraded,

enhanced or replaced entirely. A lot of the machines didn't last one or two or five years even. Many of them have been taken down in much shorter periods than that.

So I think to assume 25 or 30 years is really going on the other end of what actual experience is at this time. We haven't had machines last 30 years in big numbers, and, in fact, the actual experience shows that most of the machines are dismantled and decommissioned well ahead of them for technological development, not for anything else.

Q. With the exception of the tax credit scams, is it correct to say that no wind farm has actually ended its life yet?

A. The farms haven't, but I am talking about the machines now. Many wind farms take the one machine that was on the good site and put another machine in there, bigger, better, better blades, either the entire machines, or just the blades, or the controls on it, or something like that. There is continuous improvement to the machines as they go along.

Q. From your point of view as long as the wind farm is still producing power you don't care, do you?

A. That wasn't your question. Your question was the assumption of the life of the equipment of 25 or 30 years, is that appropriate or not?

I am contrasting that with the actual experience with the actual equipment. It is not living anywhere near that kind of life. It is being replaced well ahead of that.

Q. Your assumption of 25 years is the assumption you use to model a wind farm of 7 megawatts; correct?

A. Yes.

Q. It is not a turbine life, is it?

A. No, it is a turbine life, turbine life that would make maintenance costs and replacement costs.

Now, the financial modelling that we do is, you buy piece of equipment, you operate it for this much, you pay for it this much, you fix it up as you go along for this much, and it lives this long. That is the modelling that we have done.

Q. So then, you don't actually have an assumption for the wind farm life?

A. The wind farm life could be indefinite for all I know. If you keep replacing the

wind turbines in there it could be indefinite.

Q. Okay. It is true, isn't it, that if you assume a longer life then generally the economics are better?

A. That is correct.

Q. Because the capital costs are spread over a longer period of time?

A. That is correct.

Q. The relative size of the capital cost would make that factor even more important, won't it?

A. Yes.

Q. So in the case of renewable energy, for example, where capital cost is a very large component, like wind, plant life assumptions are relatively more important than in the case of fossil, for example?

A. I would expect that, yes.

Q. Okay. You have also assumed a capacity factor on the same page 57 of 22 per cent.

A. I am trying to see - and I have found it now - that we have done sensitivity on life on page 61 of Exhibit 344.

We have shown what the benefits would be if life changed from 25 to 30 or to 20 years. If you look at table 2-10-8, the bottom part of that page, the

third item under either option 1 or 2 says life in years. The point estimate is 25 years and the range assumed is anywhere between 30 and 20, and it shows that the benefits increase by 8.8 per cent if the machine lives 30 years instead of 25 years.

So we have a feel for what the benefit of a longer life would be and a feel of what the reduction in benefit would be if the shorter life comes about.

Q. So 8.8 per cent is quite a substantial impact?

A. It is. And the minus 11 per cent for 20-year life is also substantial.

Q. Of course. The capacity factor you have assumed is 22 per cent; correct?

A. Yes.

Q. On page 57 of Exhibit 344 it says: That's based on Ontario Hydro experience. Perhaps you can elaborate on that?

A. It is based on Ontario Hydro experience and wind speed data for Sudbury, Ontario.

Q. Yes.

A. As I indicated, we operated wind diesel turbines in the Sudbury area.

Q. Yes?

A. In Kortright area we have

measurements over several years of actual wind turbines in different locations, and the judgment we made is that 22 per cent is a good representative number to use for this kind of analysis here.

Q. Capacity factor goes up as the quality of the wind regime goes up; correct?

A. Yes.

Q. And you wouldn't suggest for a minute that your Kortright installation is in a good wind regime, would you?

A. In fact, I said it is not.

Q. All right. Just making sure of that.

And your Sudbury test, you didn't go out and find the best site, did you. You just found a piece of land and put it there; correct?

A. The site that we tested at I presume was -- we didn't go out of our way to find a bad site either. It was a good site. There may be better sites, you are quite right.

Q. It was a six metres per second site; right?

A. To my knowledge, yes.

Q. And good sites are typically more like seven metres per second; right?

A. Developers would like to see seven or

eight, yes.

Q. And the difference in power generation is exponential; correct?

A. Yes.

Q. If you could turn to the CEC report again on page --

A. Not to be very boring, but I guess we also did sensitivity on capacity factor.

Q. Oh, no. We will get to that.

A. Recognizing that it is not a hard number.

Q. If you look at page E6-3 of the CEC report there is a heading there. It says, "Capacity factor", and there the CEC says they have assumed a capacity factor of 25 per cent, and interestingly they explain that by saying the machines can do better than that but we think all the best sites are gone, so at the lesser sites we think they can get 25 per cent.

A. I see that to be the same phone conversation in reference 6.

Q. Fair enough.

A. Yes.

Q. But it is also based on actual analysis by them of the capacity factors at existing facilities; correct?

A. Yes.

Q. Okay. So why would your number be 14 per cent lower than theirs?

A. 14 per cent lower than 25 per cent?

Q. Yes. Yours is 22, theirs is 25. It is actually a big difference in terms of energy output, isn't it.

A. It is. Based on our experience - we just went through the reasons - our experience tells us that 22 per cent is representative of a decent site in Ontario, and we have done analysis to show what the benefit will be if the capacity factor was in fact 25 per cent.

Q. Exactly.

A. And it shows that the benefit increases by 9.4 per cent. So it supports your point that an increase of capacity factor from 22 to 25 per cent would yield added benefits of about 10 per cent.

Q. 10 per cent, actually. Right.

A. 10 for option 2; 9.4 for option 1.

Q. Finally, I would like to look at annual operating costs, and you made the point earlier that your annual operating costs are in the same range as the estimates of others?

A. Yes.

Q. But, of course, you don't have one figure. You have two figures; right? You have later capital costs and you have OM&A.

Isn't it correct that normally in estimating this sort of ongoing expenditure later capital costs for wind energy are included in OM&A; correct?

A. I don't know what "normally" is in the industry, but I can accept that that perhaps is the way they work, yes.

Q. Isn't that in fact what the California Energy Commission has done on page E6-3 of their report? They have used a variable cost without any fixed cost component; right?

A. Yes.

Q. And, in fact, if you compare your number to theirs taking into account the later capital would you confirm that your figure --

A. Can we find theirs again? Because I just glanced at it quickly and I can't find it again.

Q. E6-3, paragraph 3(a), 1.3 cents a kilowatthour?

A. Yes.

Q. No fixed cost component.

A. It is the same magic phone call

again. The variable cost was based on information --

Q. Well, they have also talked to another developer who gave a lower figure, right, so they used the higher one? Isn't that what they say there?

A. Yes, I see the point, 1.3 American cents per kilowatthour.

Q. Now, would you confirm that expressed in the same terms your combination of later capital and OM&A is actually 2.2 cents per kilowatthour Canadian?

A. You converted the $16 per kilowatt per year into cents per kilowatthour?

Q. Yes, at your --

A. I will accept your arithmetic. I can't do it on the stand.

Q. All right.

A. What is the comparable number in the U.S.?

Q. The comparable number, you would have to escalate the 1.3 cents from '89 to '91 and convert to Canadian.

A. Have you done that?

Q. No, I did it the other way. I got a difference of 33 per cent.

A. Okay.

Q. Does that sound about right?

A. Again, I am not going to second guess your arithmetic.

Q. Well, yes, but we need your evidence, Mr. Shalaby. Would you advise or undertake to advise whether Hydro's assumptions of wind energy OM&A are approximately one third higher than the California Energy Commission's?

MR. HOWARD: Well, Mr. Chairman, I won't undertake to do that arithmetic. To begin with, comparing that document 493 with estimates without borrowing evidence is not relevant, in my submission.

THE CHAIRMAN: I think if you want to bring evidence of that nature in, Mr. Shepherd, you can do that.

MR. SHALABY: The only thing I might add is that operating costs in cents per kilowatthour, it has got two sides to it.

The amount of money you spend, that is the cents part, and it is per kilowatthour. If you produce more energy, then the operating and maintenance cost is lower.

So on a farm that operates at 30 per cent capacity factor the OM&A per kilowatthour is lower than -- you will have the same crew maintaining the

same turbines. If the turbines operate at 20 per cent the maintenance costs will be higher than if they operated it at 30 per cent.

MR. SHEPHERD: Q. Okay.

MR. SHALABY: A. Again, the OM&A is specific to the quality of the site, and the scale of the development, and everything else.

Q. Well, in preparing your report, the Alternate Energy Review, you have given evidence that you went out and talked with other people in the industry, people who knew about these issues; correct?

A. We do that continuously, and we gathered our knowledge over the years, and we talked some more and we put our information on paper, yes.

Q. Would that have included the California Energy Commission?

A. I'm not sure whether specifically that entity was contacted or not. I don't know.

Q. Could you take a look again at Interrogatory 7.14.21, which has already been filed?

A. Mr. Dawson is bringing to my attention at page E6-3 that the OM&A that you have just presented, the 1.3 cents per kilowatthour, is a variable cost of 1.3, and we were not sure whether when you go down to item B that says "Replacement Cost"...

It says it is included in operation and maintenance, but are they talking about a variable component of operations and maintenance and a fixed cost of operations and maintenance, or not?

I just raises a question of whether --

Q. Mr. Shalaby, don't they say a variable cost of 1.3 cents a kilowatthour was used without any fixed cost component? Don't they answer your question right there?

A. But I don't know why there is another paragraph that has replacement costs in it. I am wondering why there is another category called "Replacement Costs" if it was all inclusive at the top.

Q. Don't they also say there replacement costs are included in operation and maintenance costs?

A. But not in variable operations and maintenance costs. People have different categories of costs. All they told us is variable OM&A is 1.3, and they said there is replacement costs that are part of operations.

All I am saying is we are not familiar enough with these documents to accept all of those.

Mr. Burpee - and I am glad to see my fellow witness is reading the document here - at page E6-9 is pointing to me that there is a spreadsheet;

there is a little box on the upper left-hand corner of E6-9 that shows O&M to be 1.6 cents per kilowatthour in 1989 dollars.

Q. Yes?

A. So again, that begs a question of is it 1.3 or is it 1.3 plus something else to make it 1.6? Why is there a 1.6 in here?

All I am saying, I think, is one has to know the basis of the assumptions before one draws a complete comparability conclusion to any two numbers.

Q. Okay. Perhaps you can turn to Interrogatory 7.14.21, please, same page 11 that we just looked at earlier. This is again a Hydro report, right; this is not the California Energy Commission?

A. Yes.

Q. The paragraph that starts out "What is not included...", et cetera, and the third sentence says --

THE CHAIRMAN: Sorry, page 11?

MR. SHEPHERD: Page 11.

THE CHAIRMAN: The paragraph starts...?

MR. SHEPHERD: The paragraph is about two thirds of the way down, starts "What is not included..."

THE CHAIRMAN: Must be two page 11s. All

right. I've got it now. There are two page 11s.

MR. SHEPHERD: Q. And the third sentence starts:

> The Fort Severn wind turbine is still very much an experimental unit. Maintenance costs for established wind farms in California average about one cent a kilowatthour.

So that was your 1989 information. So obviously there are operating costs as well on top of that, but it does seem to be a big jump from one cent to 2.2 cents; doesn't it?

MR. SHALABY: A. Well, it is 1-point -- no, it isn't 2.2. We have separated maintenance away from replacement costs to later capital costs. The figure we have is 1.4 cents per kilowatt in 1991.

One of the things that I find difficult to find is verifiable reliable data on operating costs for wind farms. There isn't the system that is available, for example, for fossil units or nuclear units where there is a reporting requirement by a utility to report its actual budgets on operations and maintenance that is common in various utility areas.

[12:55 p.m.]

There isn't, to my knowledge - there may

be some but I couldn't find it - a place where data is collected on a consistent basis, audited for purposes of cost reporting.

So all of the maintenance cost is really previous propriety information. Wind farm developers are very protective of their information because of competitive reasons. That data is not readily available, nor is it readily verifiable. It's all estimates and it's all discussions between experts. But there are motives of competition, there are motives of investment protection, and all kinds of reasons why this data is not openly available in the public domain.

So I think any discussion of what exactly is the OM&A cost has got to be taken with the proviso that these data are not verifiable, not audited, not collected on a consistent basis.

Q. So, therefore not reliable or less reliable?

A. I'm just saying you could hear something from somebody, you could hear something from somebody else, it depends what they include in it. It depends whether it includes replacement costs or not, whether it are includes the shell facilities or not.

I am just saying there isn't a system that's available for fossil units.

There are rigorous reporting definitions for fossil units in the United States and Canada, for example, where you can compare operation and maintenance costs from one utility to another with a little more comparability than you do with wind farm operations. That's all I want to say.

Q. What is the appropriate conclusion to draw from that fact in terms of the reliability of the numbers presented in the alternate energy review?

A. The conclusion I draw is that the numbers 1.4 or 1.6 or 1.3, or even 1.9, are all representative of operation and maintenance costs. I wouldn't make too much of a 10 or 20 per cent difference because the reporting requirements are not there, the consistency is not assured. And because people protect their information and openly tell you they will not tell you what their information is. These are people in private business, out to make a dollar, and they will not tell their competitors what their costs are. And if you are relying on one telephone conversation by one developer, it's just not a large enough sample to pin the entire discussion on. That's all I am saying.

Q. The difference between 1.4 and 1.9, say, that's enough to make on an option like wind

energy economic or not in your planning; isn't it?

A. Yes, it could be.

Q. And certainly that difference would have an influence on whether you included 40 megawatts or 400 megawatts; correct?

A. Yes. But I think until you design a wind farm and contract for the maintenance crews and construct a shop and buy the vehicles and decide on the maintenance schedule, all of that, the maintenance practices from one farm to another are quite different as well. Some let their machines rundown and replace them every now and then. Some maintain them quite rigorously on preventive maintenance programs.

All I am saying is that subject is far from being an exact science. There is a lot of data that's missing, a lot of consistency that isn't there, a lot of protectionism of the data, that's rampant in that area.

So I don't want to make too much of a difference between 1.4 and 1.6 and 1.9, that's all. I know it is sensitive, it could make or break a wind farm operation. But as best as I can determine I couldn't get to the heart of what exactly are the maintenance costs.

MR. SHEPHERD: Mr. Chairman, that may be

an appropriate time to take a rest.

THE CHAIRMAN: All right. We will adjourn until 2:30.

THE REGISTRAR: This hearing will adjourn until 2:30.

---Luncheon recess at 1:00 p.m.

---On resuming at 2:30 p.m.

THE REGISTRAR: This hearing is now in session. Please be seated.

THE CHAIRMAN: Mr. Shepherd?

MR. SHEPHERD: Mr. Chairman, I anticipate being finished before the end of the day today, you will be happy to know.

Q. We were just finishing off on wind, Mr. Shalaby. I have a couple more questions about it.

Perhaps these questions are best addressed to Dr. Effer.

You recall, Dr. Effer - maybe you don't and I will ask you - the Pace University Study of Environmental Externalities of various technologies, have you seen that?

DR. EFFER: A. Would you repeat the title again? I'm sorry.

Q. The Pace University Study of Environmental Externalities.

A. I have not read the report in detail, no.

Q. Have you seen the summaries of it, the conclusions of it?

A. No.

Q. Would you agree that the environmental externalities of wind energy are the lowest of any? That is, the negative environmental impacts of wind energy are the lowest of any currently known electricity generation technology?

A. You are referring to the operational phase of the technology?

Q. All-in.

A. I could imagine that they would be amongst the lowest, yes.

Q. Now, the only environmental problems that I could find in the transcript relating to wind were land use and aesthetics. Are there others as well?

A. If one wants to include in aesthetics appearance, noise. With the construction as they are, they do pose hazards to birds, that's another one.

Q. Bird collisions and electrocutions have in some jurisdictions been considered the most important of the environmental impacts; haven't they?

A. Yes.

Q. Are there any others that you can think of, other environmental impacts?

A. Apart from the ones that I mentioned, land use...nothing comes to mind as far as the operational aspects. I can't speak for the front end. Obviously the preparation of the materials that goes into it and transportation of those materials on to the site, construction of the materials on the site, they may pose environmental effects such as noise, dust, community impact.

Q. That would certainly be no more than, for example, building a fossil or a nuclear facility?

A. That's correct.

Q. Now we talked about land use a little while back, and you will agree, won't you, that farming and many other uses happily co-exist with the wind farm developments?

A. I believe certain types of farming will, yes.

Q. Now, aesthetics, I guess I am thinking of visual aesthetics right now, that was quite a live issue in California for quite a while; wasn't it?

A. I believe so, yes.

Q. Wasn't that whole exercise because the Mayor of Palm Springs, Sonny Bono, was very publicly opposed to wind farms in the San Gorgonio Pass?

A. I have no knowledge of that situation at all.

Q. You are not familiar with the background of the debate in California?

A. No.

Q. Are you familiar with the current position in California whether regarding aesthetics, whether there is an issue there anymore?

A. I am not aware personally, no.

Q. Mr. Shalaby, what about are you, are you aware of the development of the aesthetics issues in California, what has happened to it?

MR. SHALABY: A. I am aware that it was a big issue when farms initially came into operation, and some communities have accepted the wind farms and the concerns are not as big as they used to be, others perhaps it's still an issue. I'm not sure whether it's a non-issue everywhere or not. Some places it is not a big issue.

Q. Okay.

A. Your own Exhibit 493 indicates that:

However, local government planning restrictions and public opposition have delayed or stopped some projects from being built.

This is page E6-4. So this is a California document, they are saying that some local opposition has delayed or stopped some projects. So I presume there may be some that haven't gone ahead because of that.

Q. I am asking you whether that problem is still the case. If you don't know it's okay, you can just say so.

A. I don't know other than reading here that they are still mentioning it so I presume it's still an issue.

Q. That is fine.

Mr. Shalaby, you have seen wind farms in operation, haven't you?

A. Yes, I have.

Q. Just in your own judgment, are the aesthetics of a wind farm better, worst, or comparable to, for example, Lakeview or Nanticoke or Pickering?

A. Certainly different, that much it's safe to say.

I don't find them objectionable.

Q. Now, bird collisions --

DR. CONNELL: Excuse me, we didn't quite get to the end of that. You found Lakeview objectionable?

MR. SHALABY: I don't find Lakeview objectionable either. [Laughter]

have a friend on the panel here that's about a foot taller than I am. [Laughter]

MR. SHEPHERD: Q. Maybe I could put it to you this way: if you had a chose of having Lakeview next door to your or a wind farm, which would you chose?

MR. SHALABY: A. I think that's probably not a fair comparison because Lakeview is bigger than all of the wind farms in California put together.

So whether you have a wind farm, the comparable size of Lakeview -- and even all the wind farms in California may not produce the energy that a plant the size of Lakeview is capable of producing.

So I think the comparison is difficult to say. I think this is one of the most difficult things in the environmental assessments, is that better than that or not. The land use will be massive.

I notice the land use in page E6-8 to be 3,300 acres for 100 megawatt farm. I might have been

underestimating the land requirements when I was speaking with Mrs. Mackesy. I didn't realize the spacing has that much impact on the land requirements. But that's almost 33 acres per megawatt. That's what is shown in here.

Q. In the California report?

A. In the California report. So the land requirements are considerable. And to extrapolate that over the 2,200 megawatts or 2,400 megawatts that Lakeview is would be certainly in the tens of thousands of acres.

Now, the visual impact of that is very different than a little bunch at a time, or when you see them a few at a time.

Q. Okay. The other factor that you have talked about is noise. Dr. Effer, isn't it true that the decibel ratings of a wind farm at the same distance away from the wind farm are roughly equivalent to a high capacity transmission line?

DR. EFFER: A. I have not seen that comparison.

Q. Okay. Bird collisions as an issue have generally been solved by blade design changes; is that correct?

A. By?

Q. By changes in blade design?

A. I don't know that that would solve the problem, but I will agree if you say so.

Q. No, it's your evidence though.

Are you familiar with the problem of bird collisions in wind energy?

A. Yes.

Q. Is it correct that the problem results from birds generally not being able to see the blades; correct?

A. That may be one interpretation of the reasons why the birds collide with the blades, yes.

Q. Okay. And are you familiar with the work that's been done recently to change the markings on the blades so the birds can see them?

A. No, I have not seen that work.

Q. Okay. Wind farms give off no air emissions?

A. Correct.

Q. Solid wastes and liquid emissions are negligible?

A. That's my direct evidence, yes.

Q. There is no radioactivity or dangerous processes or materials?

A. That's correct.

Q. Let me go on to fuel cells. I won't spend as much time on them as wind.

Perhaps could you, Mr. Shalaby, turn up page 85 of the alternate energy review.

MR. SHALABY: A. Dragging this the wind discussion, I know I will regret this. You pointed out a lot of assumptions that we made that were perhaps less generous than some of the assumptions made in the California setting, there are some assumptions that we made that were more generous than done in the California setting.

Q. I was looking for one. Can you tell us what one was?

A. Let's make it sound like you are asking a question and then I will answer.

The capacity credit that we gave to wind turbines is 30 per cent.

Q. Yes?

A. Most of the utilities would give somewhere between 15 and 20 per cent.

Q. Okay. Is that because of system differences or is that because of methodology differences?

A. Because we wanted to be sure that we are doing the assessment and not erring on

shortchanging anything at all.

Q. Is that the only assumption you have made that is more generous than California?

A. I think most of the assumptions we made are generous in the Ontario context. They are different in California because of resource differences.

Q. Because of resource differences?

A. Yes, the wind resource differences. But in the Ontario context they are quite generous, things to do with capacity factor, for example, that kind of thing.

Q. But isn't your evidence that you haven't done the work yet to know what the wind resource is? Isn't that your evidence?

A. The wind resource that we know of, yes. The wind resource that we know of is less favourable than the wind resource that we know of in California.

Anyway, let's move to fuel cells. I knew that I would regret opening that. [Laughter]

Q. Page 85 of the alternate energy review has a figure at the bottom which is assumptions with respect to annual cell performance, Figure 3-10-1. All I want to do here is clear up a few things before I

get into the details so that I don't waste time.

Am I right that the capacity factor that you have assumed there for fuel cell performance, that's not the availability factor; is it? You are not assuming that you are going to run fuel cells full out whenever they are available; are you?

A. I don't think we went to that level of distinction between availability and unavailability, and parameters to do with reliability. I think the assumption was made that you would run them at 80 per cent and that will be close to what they could run at, given maintenance requirements and availability problems. So I am not sure whether we went to that distinction.

Q. So the basis of your assumption then was that you would run them all of the time they were available or not?

A. Run them 80 per cent of the time.

Q. That wasn't what I was asking.

A. I don't know whether there is more time that they are unavailable and we chose to not run them in the simulation or not.

Q. Of course that would affect the economics, would it not?

A. It would.

Q. Did you do any research to see what sort of assumptions for capacity factors were used elsewhere?

A. Yes, I think the authors of this section have done that.

Q. Okay.

A. Some are lower than 80 per cent and some are higher than 80 per cent.

Q. On the next page, page 86, you have, in figure 3-10-3, cost estimates for 10 megawatt fuel cell options, you have a line called OM&A dollars per kilowatt per year.

I take it that if we just multiplied that by size of the hypothetical station, divide it by the energy production, we will get the equivalent OM&A per kilowatthour; right?

[2:50 p.m.]

A. Yes.

Q. Okay. And when I do that using your number I get 0.9 cents per kilowatthour.

A. That can be found at table 3-10-4.

Q. 3-10-4? Oh, good.

A. Second line under the "Year 2000 Cost".

Q. No, no, no. That can't be. That is

the 200 kilowatt option, Mr. Shalaby. I'm sorry. I am talking about the 10 megawatt option in 3-10-3.

A. That shows it as 1.1 cents per kilowatthour.

Q. That is my question. Why are they different?

A. I haven't done the .9, so I don't know why they are different.

Q. Sorry?

A. I know about the 1.1. You are saying that if you -- what number did you use to get to your .9?

Q. If you just take $63 a kilowatt and multiply it by 10,000. You divide it by 8,760 and multiply by .8 you get 0.9.

I just don't understand why that and that aren't the same.

Perhaps we can come back to that in a minute because I think if I ask the next series of questions you may be assisted in that answer.

A. I am wondering whether the later capital is part of the OM&A in this case or not. I don't know.

Q. Okay. I wonder if I could ask you, then, about the fuel amount in figure 3-10-3, 2.24

cents a kilowatthour.

A. Yes?

Q. I am reading now in the year 2000 costs, I just picked one, year 2000 PAFC. If you look at 3-10-5, which is the LUECs that come out of your assumptions, fuel is 4.5. It's twice as much. Now, do you know why that is?

A. The LUECs are for an in-service in the year 2002.

Q. Yes?

A. The cost estimates I presume are dollars of 1989, but I will have to confirm that. If you could give me some time I could do that.

Q. So are these cost estimates in 3-10-5, are they dollars of the year as opposed to dollars of today?

A. I will go to the Introduction because that is where the costing assumptions are in the part on background, I think the economic assessment methodology. Pages 4 and 5, I think, have a discussion on that.

Q. All right. Because I was under the impression that all of the costs in this report were 1991 dollars. If that is not the case, then all my questions are wrong.

A. I can't readily explain the difference in those off-the-cuff like that. I will need some time to find out the difference.

Q. Well, could you undertake to provide us with why the LUEC fuel component is twice as much as the fuel per kilowatthour in the cost estimate, please?

A. Yes.

THE CHAIRMAN: Could we have a 478 number for that?

THE REGISTRAR: That will be 478.25.

---UNDERTAKING NO. 478.25: Ontario Hydro undertakes to supply reason why the LUEC fuel component is twice as much as the fuel per kilowatthour in the cost estimate, and the difference between the OM&A in the aforementioned two places.

MR. SHEPHERD: Q. I wonder if you could include in that also the difference between the OM&A in the two places. Would you do that as well?

MR. SHALABY: A. Yes.

Q. Thank you. Now, I am just looking at page 87, that chart of fuel costs, the chart that has the fuel costs on it. Those are cents per kilowatthour; right?

A. Yes.

Q. Now, fuel cells are actually more efficient typically than combined-cycle facilities,

aren't they?

A. I don't know about typically. Some of them are higher efficiency, some are them are lower efficiency. I think we gave evidence that the efficiency is somewhere between 36 per cent and 54 per cent.

Q. Yes.

A. Combined cycle is higher than 36, but perhaps lower than 54.

Q. It is in the mid-40s, isn't it, combined cycle?

A. Yes.

Q. So if you took a fuel cost let's say of molten carbonate in the year 2000 which is 3.4 cents a kilowatthour, now you are assuming a thermal efficiency there of 54-1/2 per cent. So presumably per kilowatthour the molten carbonate fuel cell uses less natural gas, less fuel than a combined-cycle facility; correct?

A. Yes.

Q. So is 3.4 cents a kilowatthour the sort of fuel component of the LUEC you see for combined cycle?

A. I think I have given the undertaking to explain the... Is that a different question than

that?

Q. Different question.

A. Hmmm?

Q. Different question.

A. I will have to defer it to Mr. Meehan, then.

Q. Who is the fuels person on the panel?

MR. SMITH: A. I am, but it depends how it was put together.

Q. Mr. Smith, typically what sort of fuel component of the LUEC for a combined-cycle plant would you expect?

A. I think Mr. Meehan will answer that question.

MR. MEEHAN: A. Mr. Meehan is going to have to ask what the question was because -- I guess I am supposed to be the LUEC expert here, but you are asking what is the fuel component to the LUEC?

Q. For a combined-cycle facility.

A. For a combined-cycle facility? I am not sure we would have it at 80 per cent capacity factor, and it would be very important it be done on the same capacity factor as the alternative you are wanting to compare it with.

Q. Now, why would that be?

A. Well, because it is a LUEC, and it is essential that if you are talking about a LUEC and comparing among alternatives the one thing that you must have the same is the capacity factor.

Q. That is true of fixed costs and capital costs, but surely that is not true of costs that vary directly with energy production, is it?

A. You may be right about that.

MR. SMITH: A. Price of fuel will vary with capacity factor, depending on the fuel. I testified to that myself extensively in my direct evidence and other cross that we had particularly for natural gas, the degree to which price varies depending on the capacity factor at which you use the transportation system.

So it is very dependent on capacity factor for natural gas.

MR. MEEHAN: A. Taking into account Mr. Smith's remark, we have 2.53 as the fuel component of LUEC for a combined cycle that is built in 2002, and so if the fuel cell we are talking about was built in about 2002 then that would be a comparable.

Q. And that, of course, is at a lower capacity factor; right?

A. That is at 40 per cent capacity

factor, and if you were to take into account Mr. Smith's remark -- I believe somewhere I have that figure, that 80 per cent capacity factor, which would have used the lower fueling price that might be available for that higher --

Q. I just find that interesting. You are talking about -- let's say 2.53 is right, that it is not actually lower because of the higher capacity factor. Let's just take 2.53 for now. That is at 45 per cent efficiency or so. Here we have something at 55 per cent efficiency that is 3.4. Now, why would that be? Same fuel; right?

A. Well, I don't know, but I would think that there are answers to this, but it is a bit difficult for us to do it on the spot here.

Q. Well, I wonder if you could then undertake to advise us why the fuel costs for your combined-cycle assumptions are lower than your assumptions for fuel costs for fuel cells.

THE CHAIRMAN: That had better have a separate 478 number.

THE REGISTRAR: 478.26.

---UNDERTAKING NO. 478.26: Ontario Hydro undertakes to advise why the fuel costs for your combined cycle assumptions are lower than your assumptions for fuel costs for fuel cells.

MR. SHEPHERD: Q. Now, Mr. Shalaby, these sorts of things we are talking about, in the case at least of the molten carbonate fuel cells, we are talking about a very significant difference in economics, aren't we? If there is a cent a kilowatthour out, then we are talking about technologies that may well be economic; correct?

MR. SHALABY: A. Yes. The projection for natural gas prices that Mr. Smith gave in his overhead S7 shows roughly a doubling of natural gas prices over the next ten years or so, and I think that may be at the root of the question that you asked: Why is it that in 1991 fuel cost is 2-1/4 cents and they become 4-1/2 cents in the year 2002.

Q. So 3-10-3 is cost today without escalators?

A. Yes.

Q. And then the LUEC includes the escalators and discounts back?

A. Yes, for a common in-service date of 2002, as indicated in chapter 1 of the report. To make them comparable to the LUECs for the thermal options they go for a 2002 in-service date. The real price of gas escalates significantly between now and then,

according to the forecast that was used.

Q. I wondered about that, and just --

A. I think the OM&A perhaps could be -- the difference again could be subject to escalation. Does that satisfy the undertaking?

Q. No.

A. It doesn't.

Q. Unless you are sure that is the answer. If that is the answer, then that is fine.

A. Can we make it that if there is any different answer we will supply the undertaking?

Q. Fair enough. Now, to get from 2.24 to 4.35 on that explanation, as I understand it, you need to have natural gas prices increasing by five per cent, or, actually, it is 4.4 per cent real every year for 30 years compounded annually. Is that what your projections are?

A. My projections are in overhead S7, and it shows the projections all the way to the year 2015. I don't know what the compounded rate of growth would be, but they go from something like between $2 and $3 for a million btu all the way to between $6 and $8 per million btu. So there is a fourfold increase, or a three to fourfold increase over the planning period.

Q. Now, if it is correct that the costs of natural gas over 30 years has a LUEC result of 4-1/2 cents a kilowatthour, then isn't the result of that - and I don't think this is for you, Mr. Shalaby; I think this is perhaps for Mr. Meehan - that natural gas fueled options are simply not sensible for Ontario Hydro, that you can't produce electricity economically if you are paying 4-1/2 cents a kilowatthour for your natural gas? Is that right?

A. I think Mr. Smith spoke about the uncertainty in natural gas prices, and the very next slide - overhead 7B it is marked in my package - shows how there are different views of what natural gas prices are going to be.

Q. Understood. But --

A. They could be going high, they could remain flat. There are various forecasts. I am just saying the forecast we used in producing the September, '91 product, the 344 was the one that showed natural gas prices increasing.

Q. I appreciate that, but I think the question still stands for Mr. Meehan: Isn't it correct that at 4-1/2 cents a kilowatthour for natural gas there is no natural gas on your system; right? It is too expensive?

MR. MEEHAN: A. First of all, we don't have natural gas on our system in a base load operating mode. It is there as a peaking resource.

For our option 6, which is a gas-fired, combined-cycle unit at 40 per cent capacity factor, the total LUEC is 7.3 and the fueling LUEC that I quoted earlier is 2.53.

What you are talking about is adding another 2 cents to 7.3, making it 9.3, and certainly if that were at 40 per cent - but I am still concerned we are mixing up capacity factors quite badly here - adding 2 cents to that, it would not compete with coal-fired generation, and, in fact, it doesn't compete with coal-fired generation at 7.3 in any event.

Q. You have an undertaking where you are going to take those fuel costs and sort of compare them and give us an answer?

A. We will get to the bottom of it.

Q. Yes. Thanks.

THE CHAIRMAN: I am a little bit confused. I thought Mr. Shalaby had answered those undertakings.

MR. SHEPHERD: The first undertaking, Mr. Chairman, he had, but the second undertaking I don't think Mr. Meehan has given an answer yet.

THE CHAIRMAN: All right. Is that right, Mr. Shalaby?

MR. SHALABY: The answer for the undertaking that I have given, frankly, I wasn't totally paying attention to the undertaking Mr. Meehan has given, and I don't know whether my answer covered that or not.

MR. MEEHAN: And I believe I have an undertaking.

MR. SHEPHERD: Q. Let me just clear up one other thing here.

On page 89, the sensitivity chart, under "Molten Carbonate Fuel Cells, Thermal Efficiency", I assume that the range there -- those are typos, correct, the range of efficiency that you have used for your sensitivity?

MR. SHALABY: A. They appear to be, yes.

Q. The correct numbers, if I understand the methodology in this, should be lower range of 55.5 and upper range of 53.5?

A. They have typically gone one percentage point on either side, you are quite right.

Q. Now, the last question I want to ask about economics is capital cost.

Ontario Hydro's estimate is that

phosphoric acid fuel cells will be commercial in 1996 and molten carbonate will be commercial in 1997; is that correct?

A. Where do you see that?

Q. Page 84. There is a chart there. You called it "mature", which I assume means "commercial".

A. Molten carbonate by 1997?

Q. Yes.

A. Phosphoric acid by 1996.

Q. Yes.

A. Yes.

[3:12 p.m.]

Q. So by the year 2000 you expect both types of fuel cells to be mature and commercially available; correct?

A. Yes.

Q. Now, on page 86 you have an assumption of capital costs for PAFC fuel cells of $1,603 per installed kilowatt?

A. Yes, for the 10 megawatt size.

Q. Yes.

A. Yes.

Q. Is that an estimate from some external source or is that prepared internally by

Hydro?

A. I think in a large measure relied upon from external sources.

Q. Can you tell us what those sources were?

A. I first go to the references to that chapter. Pages 95 and 96 have a large number of references. I cannot pinpoint exactly which reference brings that particular number.

Q. Now, if you just take a look quickly at the California report, this is Exhibit 493, at page E14-2. Sorry, E14-12. My apologies.

E14-12 has a chart of their anticipated PAFC capital costs. You will see that in the year 2000 they are looking at $990, and if you escalate that to 1991 dollars and you convert it to Canadian, will you accept subject to check that that's about $1,284 Canadian?

A. Yes.

Q. And that's about 25 per cent different from yours; right?

A. That sounds reasonable, yes.

Q. And if you look at your sensitivity analysis for costs, this is on page 88 of the alternate energy review, this is option 2, PAFC, you haven't even

modelled capital costs 25 per cent lower than your projection; have you?

A. We modelled only 10 per cent lower.

Q. Okay. The same thing is true of molten carbonate; isn't it? If you look at page 86 of your report, your year 2000 projection is $2,003 a kilowatt?

A. Yes.

Q. If you look at page E14-6 of the California report, you will see there capital costs for the simplified design. The simplified design is the one that you are looking at in your report; right?

A. I don't know what they mean by simplified design.

Q. I am trying to find the reference. They are two different designs for molten carbonate fuel cells; aren't there?

A. There could be even more than that. I don't know what is meant by integrated design versus simplified design. I just don't know.

Q. Okay. Let me come back to your cost component sensitivities. This is on page 88 of the alternate energy review.

A. Yes.

Q. And for both phosphoric acid and

molten carbonate you have used a strongly asymmetrical capital cost sensitivity; correct?

A. Yes.

Q. And why is that?

A. Because of the expert opinion and the people preparing this report, they felt there is a higher likelihood of the costs exceeding the point estimate than coming to below the point estimate.

Q. So when we look at your LUEC range on page 91, or indeed in - where is it - figure 3-10-11, you have a LUEC range for each of the options that shows that the upper estimate is sort of very expensive, right? At least 10 cents a kilowatthour is expensive power; right?

A. Yes.

Q. But we have to recognize that in that sensitivity analysis you have included highly asymmetrical capital costs; haven't you?

A. Yes. Now the dominant component in all of this is the fuel cost really, not the capital or the operating cost. At least 50 per cent of the cost, sometimes more, is the fuel costs.

But I acknowledge what you are saying that we have included in the sensitivity asymmetrical distribution of capital cost.

Q. If you just look at page 88 in that chart, Cost Component Sensitivities, and look at molten carbonate, option 4, the 40 per cent increase in capital costs that you have assumed in your sensitivity, that is approximately a 22 per cent increase in LUEC; isn't it?

A. Yes.

Q. Okay. So it's about half your LUEC increase on page 90; isn't it?

A. Yes.

Q. Can you tell us who the American Public Power Association is?

A. I think it is an association of municipal utilities, the equivalent of municipal utilities. They are called cooperatives I think in the U.S., or municipal distributing utilities, that's my understanding.

Q. It's something similar to the MEA; isn't it?

A. To the extent simplifications can be allowed, yes.

The MEA must think they are totally unique, but it's something like that, yes.

Q. Can you tell us what the APPA sponsored fuel cell commercialization group is?

A. I think we have references made to that APPA on page 95.. It's a group interested in -- for example, the third reference at page 95 is a report on APPA's notice of market opportunity, Niagara Mohawk for fuel cells initiatives. So the American Public Power Association and the Electric Power Research Institute are interested in commercializing fuel cells, or seeing some manufacturing an demonstration capabilities shown over the next seven years.

Q. It's specifically targeted to molten carbonate; isn't it?

A. I don't know whether that's the technology they are focusing on or not. You could be right, I don't know.

Q. You are not very familiar with what they are doing?

A. Not exactly what technology they are sponsoring. I was at one time but I can't figure it out now.

Q. You were at one time?

A. If you go to page 92...

Q. Yes?

A. On the left-hand column .8, it says the American Power Association has taken an active interest and role in promoting the development of fuel

cell technology.

Q. There is actually a full explanation of it on E14-5 and E14-6 of the CEC's report.

A. Okay.

Q. Now, my question to you is: Why would a commercialization initiative on the part of utilities be necessary for a technology such as this? Why wouldn't they just wait until the things were manufactured and then stand in line and buy them?

A. Is your question, why are the utilities interested in this?

Q. Why would they have a commercialization initiative as opposed to letting the manufacturers do it?

A. To get to understand the technology and to know what it is that they will buying and planning for.

Q. So this is are R&D?

A. They are also offering a test bed for these utilities to operate under real life utility conditions.

Those are sort of the general reasons why utilities get into commercialization and demonstration activities.

Q. Is that the reason why the APPA is

promoting fuel cells?

A. They must be part of the reasons. I don't know what their full reasons are.

Q. You are not familiar enough to know?

A. No.

Q. In your experience in reviewing new technologies, particularly new energy production technologies, is it fair to say that there is often a market imperfection when you move from a proven non-commercial technology to a commercially available technology; that is, the market has barriers to commercialization?

A. Of new unproven technologies?

Q. Of proven technology which is not yet commercialized?

A. If you mean by that lack of familiarity, lack of track record to give confidence to the people buying the technology that it will work reliably, and so on, yes that is a market barrier.

Q. In fact, what Hydro did a long time ago in supporting CANDU technology was overcoming such a market barrier; wasn't it? A new technology that worked but nobody would buy it?

A. What part of that is the question?

Q. Isn't what you did with CANDU the

sort of initiative where you overcome market imperfections, market barriers to commercialization of a new technology?

A. Yes, together with other Canadian utilities, but, yes, Hydro did it.

Q. Yes. Mr. Passmore reminds me that CANDU is not yet a commercial technology. That's not a question.

Ontario Hydro has taken no steps similar to what the APPA is doing, or indeed what you did with CANDU, to try and help commercialize any fuel cell technology, has it?

A. I think we described the activities that we were involved with in terms of fuel cells in the report.

Q. But it's a simple yes/no question. Either you have got --

A. It isn't a simple yes/no situation.

We are involved in monitoring fuel cell activities. We have a fuel cell at our research lab that we are modifying and working with and understanding. We belong to some of these consortiums that are looking at commercializing and developing fuel cells.

As I mentioned in my direct testimony, it

is no longer a single utility developing a technology; it is always a group of utilities pooling their resources and information and expertise to develop a particular technology, and we are part that group.

Q. Of which group?

A. Part of the group of utilities taking interest in commercializing fuel cell technologies. I am not sure whether we are part of the APPA now, I don't know that. But that is the nature of participation in the development of technology.

Q. The raw materials for molten carbonate fuel cells are readily available in Ontario; aren't they?

A. Yes.

Q. And the manufacturing techniques required for commercial production for those are for the most part similar to techniques found in a lot of operations in Ontario; isn't that correct?

A. I don't know that for a fact, but I know that Ontario has a wide range of skills and sophistication in manufacturing.

Q. What I am getting at is, there is no reason why the fuel cells couldn't be manufactured in Ontario, is there?

A. I suspect not, with enough lead time.

Q. Okay. And Hydro I think has said in the alternate energy review that fuel cells represent a substantial future market; isn't that correct?

A. Yes.

Q. Wouldn't it be fair to say that if Ontario Hydro promoted fuel cell commercialization in Ontario, that there is the potential for significant economic activity in Ontario?

A. Probably, yes.

Q. In fact, in some respects, that's what happened with CANDU; isn't it?

MR. SMITH: A. I would like to dispute that position that you have taken on CANDU. The commercialization of CANDU, what I would call, notwithstanding your advisor's opinion, occurred with the development of the Pickering plant, Pickering "A", and Ontario Hydro in fact entered into an agreement with the Ontario government and Atomic Energy of Canada Limited to finance that project.

I forget the exact statistics, but I believe the government funded and AECL funded 60 per cent or two-thirds of the cost of that plant, Hydro's share being related to the capital cost of then conventional technology of a coal plant. They entered an agreement to share in the risks and costs of doing

that technology.

So I believe the big support for development of that technology was in fact not from Ontario Hydro but from the Government of Ontario and Canada, and perhaps that might be the way fuel cell technology should be developed.

Q. From what source are the largest annual contributions to AECL presently? Isn't it true that Ontario Hydro contributes more than anybody else?

A. I don't know. Panel 9 can answer that question.

I am talking about when this was developed which was 1965, which is nearly 30 years ago, was the arrangement to build Pickering. And certainly there have been many changes in that arrangement and many changes in the funding of nuclear development since then.

Q. The result of the initiative in CANDU, I didn't mean to get into nuclear, it was just by comparison, the result of the initiative in CANDU was jobs and manufacturing activity, et cetera, in Ontario; correct?

A. I think in Ontario and in Canada, yes.

Q. Ontario Hydro has taken no steps to

initiate any similar programs or directions for any renewable technology or fuel cells or anything else; has it?

MR. SHALABY: A. That's what I am saying, it isn't black and white, you haven't taken any steps or you have taken a giant leap. We have taken small steps.

The report, for example, on page 79 describes the Ontario Hydro experience and the Ontario Hydro initiatives. It says Hydro established a fuel cell task force group; Ontario Hydro has provided funding to Westinghouse to perform a concept design study of a solid oxide fuel cell plant for use in Ontario; it says Ontario Hydro has joined two inter-utility groups to gain a window on the development of molten carbonate fuel cell technology; it says Hydro is testing and obtained a 40 kilowatt phosphoric acid fuel cell.

So I wouldn't characterize that as Ontario Hydro has not done anything at all. Those are steps that are taken to become familiar with the technology and to become aware of the development issues and to give a signal to the corporation when these technologies are mature and ready to go, we can take advantage of it.

Q. That's quite different from building a 2,000 megawatt nuclear facility?

A. It is quite different, yes.

MR. SHEPHERD: Mr. Chairman, that might be an appropriate time to break as I am going on to a new subject.

THE CHAIRMAN: Are you still on track?

MR. SHEPHERD: Yes, I am.

MR. SHALABY: Before we leave that, I think we have got to say that the first CANDU experience was not a 2,000 megawatt. The first steps were Chalk River, several megawatts, 22 megawatts at Chalk River facility, and so on. So you don't step from zero to 2,000 in CANDU, that was not an accurate characterization.

MR. SHEPHERD: Q. Right now you are at 40 kilowatts in the fuel cells; right?

MR. SHALABY: A. That's right.

THE CHAIRMAN: We will take a 15-minute break.

THE REGISTRAR: The hearing will recess for 15 minutes.

---Recess at 3:30 p.m.

---On resuming at 3:46 p.m.

THE REGISTRAR: Please come to order.

This hearing is again in session. Please be seated.

MR. SHEPHERD: Q. Dr. Effer, perhaps I could ask you some questions about the environmental impacts of fuel cells.

I went to the alternate energy review and I didn't find much in the way of details on air emissions associated with fuel cells. Perhaps just to get a sense of it, could you compare the, let's say, sulphur dioxide produced by scrubbed coal as opposed to fuel cells?

DR. EFFER: A. On the assumption that we are dealing with natural gas as fuel, it is very, very much reduced, causes a very small quantity. The sulphur will be scrubbed out of the natural gas and taken up as a solid material. So the air emissions of sulphur will be very, very small.

Q. Of course, that is because you can't have sulphur in the reformed fuel when you put it into the fuel cell, can you?

A. That is right.

Q. And that is comparing it to scrubbed coal where you have already tried to scrub the sulphur out of the coal; there is still some sulphur left?

A. Yes, depending on the efficiency of the process. Yes.

Q. Similarly, with nitrous oxide --

A. Nitrogen oxide.

Q. Nitrogen oxides, NOx. Can you compare the two again, fuel cells and scrubbed coal?

A. Very, very low levels in fuel cell emissions compared with coal, and possibly lower with selective catalytic reductions as well. Compared with that it is still very low.

Q. That is, fuel cells are still very low as compared to coal?

A. On the assumption that selective catalytic reduction would be around 80 per cent, the nitrogen oxide emissions probably would be comparable.

Q. For...?

A. That is, weight per energy produced on an emission rate basis.

Q. Okay. What about carbon dioxide? Is there a substantial difference between carbon dioxide produced by coal generation and fuel cells?

A. Just to go back to nitrogen oxides, I don't think I was clear. With SCR, I think the nitrogen oxides would still be lower for the fuel cell emission rates.

To go to carbon dioxide, if you are using natural gas the amount of CO(2) in the hydrogen forming

would be the same. That is assuming that it all goes to CO(2) and not to carbon monoxide. And the emission rate would be lower to the extent that the plant efficiency for the fuel cell process would be higher.

Q. Would it be fair to say that if you compared the CO(2) emissions of a scrubbed coal plant and let's say a molten carbonate fuel cell that the fuel cell would be maybe 15 or 20 per cent of the coal plant? Are we in the right range?

A. No, I wouldn't put it that high. It is only in proportion approximately to the conversion efficiency, and we are talking probably about -- something a little more than half the emission rate of carbon dioxide for a fuel cell compared with a scrubbed coal burning plant.

Q. Just to try to get an idea of some of the numbers I went to the CEC report, which does have a list of numbers. I wonder if you could turn to page E14-4 of Exhibit 493.

A. Sorry, which page?

Q. E14-4. Now, can you take a look at those atmospheric emissions numbers and advise us whether they look to be accurate to you for a phosphoric acid fuel cell power plant?

A. I can't readily do that conversion

from pounds per million btu to grams per kilowatthour, and I am assuming that CO there is CO(2) on that table.

MR. DAWSON: A. That is carbon monoxide.

Q. Dr. Effer, perhaps we could short circuit this.

I wonder if you could undertake to provide us with a chart that shows the air emissions of the various important pollutants per kilowatthour for, let's say, molten carbonate fuel cells as compared to scrubbed and unscrubbed coal.

Could you undertake to provide that sort of chart for us?

DR. EFFER: A. Yes, we can do that.

Q. Thank you.

THE CHAIRMAN: I take it that is not set out in 344 anywhere; is that right?

MR. SHEPHERD: No, it isn't.

DR. CONNELL: I notice just in the next section down there is a reference to solid waste of 2.7 tonnes per day. Over on page E14-8 there is no comparable section for the molten carbonate. Is there no solid waste from the molten carbonate fuel cell?

DR. EFFER: Very small amounts, Dr. Connell. The zinc oxide which is used to pick up the sulphur is converted to zinc sulfide and is used -- and

it will be one solid waste. There are no other substantial ones.

MR. SHEPHERD: Q. And that zinc sulfide is actually recycled?

DR. EFFER: A. That is correct. It is not usually recycled within the plant. It is usually sent away to be reclaimed.

MR. SHEPHERD: I wonder, Mr. Chairman, if it is possible to get an undertaking number for --

THE CHAIRMAN: Shall we have an undertaking number, a 478 number?

THE REGISTRAR: 478.27.

---UNDERTAKING NO. 478.27: Ontario Hydro undertakes to provide a chart showing air emissions of various important pollutants per kilowatthour for molten carbonate fuel cells as compared to scrubbed and unscrubbed coal.

MR. SHEPHERD: Q. Dr. Effer, just going back to CO(2) for a second, the CO(2) emissions of a gas combined-cycle facility are a little less than half a scrubbed coal facility, aren't they?

DR. EFFER: A. Yes, that's right.

Q. Then if you ramp up the efficiency to let's say a molten carbonate fuel cell that would reduce the CO(2) per kilowatthour, wouldn't it?

A. Yes.

Q. Okay. So it would be then that much less than half of what coal would be?

A. We are talking of CO(2) here?

Q. CO(2).

A. Yes, I said that it was a little less than half.

Q. Could you take a look at page E14-5 of Exhibit 493? There is a paragraph there under the heading "Economic Parameters". The paragraph starts with the word "Overcoming" you will see there?

The statement is made: Members of the American Public Power Association - this is about halfway, or a little ways through the paragraph:

> Members of the American Public Power Association, APPA, found fuel cells to be especially attractive for their use because fuel cells can offer environmentally benign service generation at high efficiency and with easy siting.

Now, Dr. Effer, do you agree with the statement: Fuel cells can offer environmentally benign service generation at high efficiency and with easing siting?

A. As I said in my testimony, the emissions are low. On a comparative basis, yes, I

would agree that it is comparatively and environmentally benign, and, as far as operation is concerned, it does have qualities that lend the process more attractive for siting; that is, low noise levels, for example, in addition to the low emissions.

Q. Still dealing with environmental impacts, on page 81 of the Alternate Energy Review, Dr. Effer, in the lower right-hand corner Hydro says -- this is page 81 of the alternate energy review?

A. Yes.

Q. Hydro says:

> Decommissioning of the remainder of the fuel cell facility - this is after the fuel and the active elements - should be similar to decommissioning a conventional power plant.

Do I take it that you are saying there that decommissioning a fuel cell plant has roughly similar environmental impacts to decommissioning a coal facility?

A. Certainly, the types of materials that are being disposed of are different. I think the intention there was to say that it would be of a comparable complexity. Obviously, it would be quite different in terms of the materials to be disposed of

and the dismantling.

Q. In a coal facility you have a lot more environmental problems you have to clean up in decommissioning; isn't that true?

A. I think there are some areas where they are more of a problem than with a fuel cell, yes.

Q. Let me turn, Mr. Shalaby, to photovoltaics. I think my friend Mr. Grenville-Wood will spend more time on this than I will, but I do have a couple of questions on it.

Why don't we start maybe 15 or 20 years ago. It is true, isn't it, that at that time photovoltaic arrays, if you would like, had a capital cost in the order of $50 a peak watt, that sort of range?

MR. SHALABY: A. Yes.

Q. Which is equivalent to $50,000 a kilowatt; right?

A. Yes.

Q. And if we ramp that up to today's dollars we are talking about -- very expensive, $100,000 a kilowatt generation; right?

A. Yes.

Q. Correct? okay. But in the interim time it is true, isn't it, that photovoltaic

applications, particularly consumer applications, have become sort of a ubiquitous sign of the times. We see them on calculators and we see them on watches and all over the place. The technology has advanced dramatically in that period of time, hasn't it.

A. Yes.

Q. Isn't it true that 15 years ago amorphous silicon, which is the sort of material of choice today, was just a lab concept?

A. Yes, that it was a lab concept. I am not sure if it is the material of choice today. I don't know whether I can detect a clear winner in the photovoltaic materials and manufacturing methods yet.

Some people are betting on amorphous technology. Others think it will have limitations for a long period to come.

So I am saying to one part of your question, but I am not sure that I am endorsing that amorphous is the clear choice today.

Q. Amorphous is being produced in commercial quantities today; is that correct?

A. Yes.

Q. And technologies like non-amorphous, thin filmed cells, multi-layer cells, those were all just ideas 15 years to ago and they are now being

produced in significant quantity today, aren't they?

A. They are certainly more than just ideas; they are being produced, yes.

Q. We are now not talking about $100,000 a kilowatt, are we. We are talking about in the order of $6,000 or $7,000 a megawatt -- kilowatt, rather?

A. Yes.

Q. Could you turn to Exhibit 504, please. This is a paper by Dan Shugar of Pacific Gas & Electric on distribution benefits of photovoltaics. I am going to come back to the central element in this paper in a moment. I would just like you to look at page 7 of that paper for a second, Mr. Shalaby.

A. Page 7?

Q. Seven. In the upper left-hand corner of that page PG&E is using a number of $6.50 a watt for 1992 installed cost for PV, am I correct that that is $6,500 a kilowatt?

A. American, yes.

Q. Would you agree that that number is the right sort of range to use for capital costs for photovoltaic systems?

A. Yes. It is close to the number that we are giving in our own Exhibit 344. I think we have given something like 7,000 or 8,000 Canadian.

Q. You have used 8,200 in 1981 dollars, and that is about, what, 15 per cent higher?

A. Yes.

Q. That is the right range?

A. That is the right range.

Q. And it is correct that the cost of generating electricity through photovoltaics is almost exclusively driven by the high capital cost?

A. Yes.

Q. Perhaps could you look at page 34 of the alternate energy review, please. You will see in paragraph .8 there in the left-hand column--

A. Yes.

Q. --that you give a capacity credit for photovoltaics of 20 per cent of rated capacity.

A. That is correct.

Q. And in order to do that you are basing that on the likelihood of the capacity being available at system peak; is that correct?

A. Yes.

Q. That is winter peak probability you are using there, isn't it?

A. That is right.

Q. Now, you have said in paragraph .7 above that highest probability of PV power is at summer

peak; right?

A. The highest?

Q. Highest probability of PV providing capacity at a given time is summer peak?

A. That is right.

Q. And if you look to the chart above that, isn't it correct that the probability of capacity at summer peak is about 45 per cent?

A. You are dividing 918 by the total energy production?

Q. No, I am dividing 918 by total summer peak hours. That is what your probability is; isn't it?

A. So what does that number give you then?

Q. 45 per cent?

A. Sounds about reasonable, yes, that during summer peak hours photovoltaic is producing electricity 45 per cent of the time.

Q. That is how you get the probability number for capacity credit, right, except you use winter peak?

A. I don't know whether it is exactly that method or something close to it, yes. I am not sure whether it is exactly that kind of arithmetic or

not. It is probably rounded, something close to that but rounded.

[4:05 p.m.]

Q. So is summer peak power not valuable to Ontario Hydro?

A. It is valuable.

Q. Is the capacity available at that time valuable?

A. Yes.

Q. But this calculation doesn't give any value to summer peak capacity; does it?

A. It gives more value to winter peak capacity. We are a winter peaking utility.

I think we discussed at some length in Panel 3, whether the capacity credit should be split between winter and summer or remaining all assigned to the winter period, whether we are becoming more a summer peaking utility. I think we have had some discuss on that.

There are views that perhaps capacity credit should be split between the summer and winter and not put altogether in the wintertime.

Q. As of right now though, and as of the numbers that you provided in the alternate energy review, there is zero credit for being available on

summer peak; is that correct?

A. Zero credit in terms of deferring generation capacity.

There is credit in deferring transmission distribution capacity, and there is $20 per kilowatt per year for distribution, there is $7 for the regional system, there is $12 for bulk transmission. All of these things times our summer peaking. So I think there is transmission distribution credits given and many of those could be because of the summer peaking nature of photovoltaic.

Q. Maybe I am just remembering the cost methodology wrong. But I thought that when you did your transmission and distribution credits you multiplied them by the same factor as your capacity factor; didn't you, as your capacity credit? As part of the same chart you add them all up and multiply by the same 20 per cent?

A. You are right in that, but the reason we give capacity credit for generation deferment in the winter, you add to it deferment of transmission distribution and regional supply facilities and those could be peaking in the summer.

I am coming to the point that, yes, it does have value in deferring some capacity in the

summer; it is not generation capacity but depending on the local circumstances it could be transmission and distribution capacity.

Q. Well. In your transmission and distribution - and maybe I just misunderstood this - don't you take the numbers in your system incremental cost and multiply them by the same percentage as you apply to the capacity credit?

A. Yes.

Q. So you only give 20 per cent of the transmission and distribution benefits?

A. That's right.

Q. Exactly the same as the generation?

A. That's right.

Q. Okay.

Isn't it correct, Mr. Shalaby, that if you used the summer peak number for photovoltaics instead of the winter peak number, that the cost/benefit ratio that you show here for photovoltaic of - if I can find it. I can't even find it now.

Your point estimate is 2.1; right? Cost/benefit ratio, point estimate is 2.1; is that correct?

A. For option 2, the year 2000?

Q. Yes.

A. That's correct.

Q. If you use the summer capacity credit instead of the winner capacity credit it would be 1.6, wouldn't it, roughly?

A. It would be lower. Whether it's 1.6 or 1.5, I don't know.

Q. Let's come back to these transmission and distribution credits or benefits, whatever they are. Could you take a look at page 34 of Exhibit 344, in paragraph .14?

A. Yes.

Q. Now, am I correct that about 20 per cent of the net present value of the total benefit for a PV installation is T&D benefits, this sort of benefit?

THE CHAIRMAN: What page are you on?

MR. SHEPHERD: This is page 34 of Exhibit 344, the alternate energy review, in paragraph .14.

THE CHAIRMAN: Thank you.

MR. SHALABY: I guess you are still asking me to translate dollars per kilowatt per year into cents per kilowatthour. I cannot do that on the fly, but if you have done it and those are the numbers....

MR. SHEPHERD: Q. I am just asking you,

am I in the right range? It's not 100 per cent?

MR. SHALABY: A. No, they are not.

Q. It's not 1 per cent. The 20 per cent range is about right?

A. Sounds reasonable, subject to check.

THE CHAIRMAN: Is this the paragraph where the $10 has to be changed to $20?

MR. SHALABY: That's correct, Mr. Chairman, yes.

MR. SHEPHERD: That's correct.

Q. Now, perhaps you could then turn to, Mr. Shugar's papers, which is Exhibit 504.

Mr. Shalaby, were you familiar with this work, this research work done by PG&E prior to seeing this exhibit today?

MR. SHALABY: A. No, not this particular paper.

Q. Were you aware of the work being done on distribution benefits by PG&E?

A. In general, yes.

Q. Okay. Now, this paper is obviously too technical for me most of the time in most places, but it does appear to me - and correct me if I am wrong - this represents a technical analysis of the potential transmission and distributions benefits

available from distributed PV installations; is that a fair characterization, Mr. Shalaby?

A. This is something I am seeing for the first time and haven't read, the title says so, yes.

Q. Okay. If you could turn then to page 7 of the paper. There is a chart there that is a schematic and what it appears to show is the benefits, monetary benefits, of a PV installation as compared to cost. Do you see that?

A. Yes.

Q. And if I understand this correctly, and maybe you can correct me if I don't understand it right, the benefits of distribution are a much, much greater proportion of the total than your 20 per cent?

A. That's what they appear to be, yes.

Q. Has Hydro done any technical work comparable to the PG&E work to determine whether it could obtain similar benefits in Ontario?

A. Not to my knowledge, no.

Q. If you take a look at that chart you will see there is a dotted section in the chart and the legend says that that's called kVAR Support. In fact, that's discussed on the previous page under the heading Reactivate Power Value. Can you describe what this benefit is?

A. It says:

Reactive power value is a result of voltage support to the T&D system. Power flow calculations showed that a 500 kW array installed at the Kerman site would reduce peak reactive power losses by a surprisingly large 452 kVAR.

Q. I appreciate that that's what it says. I guess I am wondering, could you explain that in English.

A. Well, I guess the power system needs voltage profile support and that was discussed by - I forget who now - but the idea that the people at the end of a distribution line could benefit more from people elsewhere, and I think some interrogatories touched on that as well.

And providing reactivate power at certain times of the day, different parts of the system in different systems costs money. So in systems can benefit from provision of VARs, VARs are the units measuring the reactivate power, to different extents than other systems.

Q. Now, your transmission and distribution benefits in your avoided costs, they don't include kVAR support; do they?

A. Not explicitly, no.

Q. The biggest benefit listed by PG&E in this chart on page 7 is called Reliability, and you can see there is a discussion of it on the previous page. But just rather than make you read that, if you take a look at page 7, at the end of the first column text, you will see it says there:

> Economic applications of PV-T&D are seen to depend on the treatment of reliability benefits, the installed cost of the PV system, and the availability of solar tax credits.

Now, your numbers don't include any reliability benefit either, do they?

A. The analysis we have done is not that detailed, no. We don't have a reliability benefit nor do we have a reliability disbenefit.

We are assuming the reliability of photovoltaics would be neither a hindrance nor an addition to the places being added here.

Q. But if we look at the chart that PG&E has produced, that is a very large proportion of the total benefit of photovoltaics?

A. I am actually not sure what proportion of the large chart corresponds to

reliability. Is it the small cross-hatching or the large cross-hatching?

Q. It's the large cross-hatching. You can see that the small cross-hatching is loss savings. You do include that; right?

A. Yes.

Q. And you also include what is here the double cross-hatching, which is T&D savings; correct?

A. Yes.

Q. Now, to be fair, the numbers that you use for transmission distribution benefits, those are system wide averages; aren't they?

A. Yes.

Q. And they are not technology specific; are they?

A. No, nor are they location specific.

Q. Fair.

A. I think these things are quite sensitive to location and technology in applications.

Q. That's I guess what I was going to drive at. If you look at page 8 of Shugar's paper, Exhibit 504, you see in the first complete paragraph on the left-hand side, he says:

> Indiscriminate placement of generation in T&D systems can result in detrimental

impacts that could be greater than benefits described. This re-emphasizes the site-specific nature of distributed benefits.

I guess what that suggests is that there is a potential if you can find the right sites to get substantially larger transmission and distribution benefits from distributed generation like PV. Have you done any work on that to see whether this sort of benefit could be obtained in Ontario?

A. Well, not in the context of PV generation, not in this kind of detail. Not at the distribution system and so on.

Q. If we use the sorts of numbers they are using here with your methodology in the alternate energy review, that would change the conclusion on PV; wouldn't it?

A. I would have to understand the methodology first. I am still a bit perplexed with that reliability. I'm not sure whether this a system that has storage in it or not. A system that operates 20 or 25 per cent of the time is unable on its own to provide reliable service continuously. So I want to understand whether it has storage associated with it or is it with a backup from the network and where do these

benefits come from. So I am unable to comment on to what extent this is comparable to what we have done or what it would do to our results, I don't know.

Q. Let me just ask one other question on photovoltaics. Could you confirm that if you applied the total customer cost test, which is what you apply to demand management, instead of the avoided cost test, to load displacement photovoltaic installations, that you would find a number of locations in Ontario where on-grid PV would be economic or very close to it?

A. You are asking me to...

Q. I am asking to you hypothetically apply the total customer cost test to load displacement PV. I am asking whether they are places in Ontario where - on grid - the result would be that those installations would be economic or close to it?

A. The places where my mind will go to would be somebody on the rural distribution system or a remote community that use a small amount of electricity, that sort of they get into the early part of the rate schedule or get the brunt of the fixed costs. Certainly remote communities, I would expect that total customer costs tests today would yield a positive result, places where we fly diesel fuel, for example.

Q. But I am asking about on-grid applications?

A. On grid, I don't know whether a cost/benefit ratio of 8.8, which is what we have seen, whether they are places where the cost is eight times the average cost or the average avoided cost. I would be hard pressed to find one of those. Unless there is a very peculiar application somewhere. So there may be, I think if you look hard number there may be, but I don't know how ...

Q. Hydro hasn't looked for them?

A. Not actively, no.

Q. One final thing on solar --

A. Again, with the expectation that we won't find any. We have a technology that is 8.8 times the avoided cost, we would start looking for applications for other things before we would look for applications for this. So we haven't looked not because of lack of enthusiasm for this; it is just that we don't think the cost is low enough to justify a total customer cost saving at this time.

Q. Not everyone agrees with you that the cost is eight times the benefit; is that correct?

A. Well, we have had Mr. Cuyler here who is a practitioner photovoltaics, he told me, and he

didn't disagree with those costs. In fact, he thinks the costs are of similar to what we have put together.

Your own PG&E exhibit shows 6,500 American dollars. It's not very different from the costs that we have shown.

Q. If you look at page 7 of that exhibit, and ignoring the solar tax credits, treating that has being a cost, the difference between the 1992 PV cost and the benefits that they have calculated isn't very much; is it? It's certainly not eight times.

A. Not in that particular application. But I don't know exactly what they are doing there.

Q. Okay. I have only one other question on solar, that has to do with power towers, solar power towers. We talked about them earlier.

A. Yes.

Q. Could you turn to Exhibit 506. This is a fact sheet prepared by Sandia Labs. Could you tell us s who Sandia Labs is?

A. It's one of the national laboratories in United States, scientific laboratories doing work in energy and other matters.

Q. It's a large research facility?

A. Yes.

Q. This is a fact sheet on the project we talked about on Thursday, this Solar Two project.

If you just look at the upper right corner there, there is a heading Solar Power Towers' Advantages, if you could just read through that quickly.

A. Yes.

Q. Can you confirm that if the power tower demonstration currently being developed by utilities in United States works as they expect it to, that these are the benefits that one would expect that they would get out of that technology?

A. I have no dispute with some of the points, but when you get to cost is comparable with alternatives, when you get to every component that's tested and proven, when you get to future commercial plants from the 100 to 200 megawatts plants, I have no basis to know whether that is correct or not.

Q. The other ones are fine, though?

A. Practical energy storage, yes; capacity factors up to 60 per cent is really a function of the design, how much storage you design into. Dispatchable, again you can make it dispatchable, at what cost is the only question left. Clean, reliable source of electricity, zero emissions, I have no

difficulty with that.

Q. Okay. Let me turn to biomass. It's correct, isn't it, Mr. Shalaby, that in the alternate energy review, you have only looked in detail at a few of the potential biomass applications?

MR. DAWSON: A. We have looked at wood, basically.

Q. At one?

A. At wood.

Q. At wood, yes.

So, for example, if you take a look at page 97 of the alternate energy review, in paragraph .6 you refer to agricultural wastes and then you just sort of dismiss them and you don't deal with them again, do you?

A. I think what we are saying is that we would expect those to come in at a higher price than wood because they are more dispersed.

[4:29 p.m.]

Q. I am going to ask you to turn, then, to Exhibit 503, and this is a report of the California Energy Commission from last June, or excerpts from it, on biomass energy potential.

Could you just look at page 1-113, please?

A. Right.

Q. As I understand what that chart says, agricultural field crops, that is agricultural waste; right?

A. Well, I haven't seen the paper before, but I would assume that is what it means, yes.

Q. Okay. That 13 in the far right column, that is 130 million barrels of oil; am I right there?

A. That is what it --

Q. 10(6)?

A. 13 million barrels of oil is what --

Q. 13 million? Right. Okay. That is about 60 per cent of the wood waste potential it looks like.

A. Yes.

Q. Then if you look several pages on you will see pages 8-3 and 8-4. These are lists of biomass facilities in California.

A. I'm sorry, where are you?

Q. 8-3 and 8-4.

A. Oh.

Q. Just look down the list. There appears to be a fair bit of agricultural generation. We are talking certainly hundreds of megawatts, aren't

we?

A. Yes, there appears to be, yes.

Q. The figure that we looked at of 13 million barrels of oil a year, is that a big number? Is that a lot of energy or a little energy? Can you give us a benchmark so we can figure out how much we are talking about?

MR. DAWSON: A. Yes. I haven't calculated what it is in megawatts, but yes, it is a lot of energy regardless.

Q. So we have substantial agricultural applications in Ontario, don't we? The agricultural industry in Ontario is quite substantial?

A. Yes, though it depends to some degree on -- I don't know what crops all this agricultural waste is coming from and how concentrated it is relative to ours. I don't know.

Q. I guess I am just wondering why a technology which is obviously working in California would be excluded entirely from your review.

A. I don't know, other than all we are really trying to do is assess some sort of a potential. We are not excluding anything by our review. If it is available and somebody wants to generate electricity from it, then they are free to do so.

MR. SHALABY: A. I think your exhibit also shows that wood is still a larger resource than agricultural waste. And in Ontario that is much more the case, and wood is a much larger resource than agricultural waste.

California is a much larger producer of food products than Ontario and the nature of their agricultural waste could be different than here as well.

For example, I have seen agricultural waste in the California area where it is almond shells, for example, which is almost wood again. It is fairly high in energy content. I don't know whether we have anything like that here.

So I think transporting conclusions from one state with a different agricultural base to here one has to do that with a bit of care.

We felt that wood is dominant in Ontario, agriculture is not, and as I indicated to you earlier, the scope of the study was to look at areas that are more promising. There may be other areas that are still contributing in some way but not in a significant way to alter our conclusions.

Q. Can we take it, then, that Ontario Hydro has no evidence to offer on agricultural waste

and energy generation?

MR. DAWSON: A. Not to my knowledge.

Q. Thank you. Now, you also didn't look in any detail at forest waste, right, what is called "slash"? Are you familiar with that?

A. We have looked at forest thinning. That was estimated as part of the alternative energy study, the cost of forest thinning.

Q. But forest thinning and forest waste, or slash, are not the same thing, are they?

A. Slash, as I understand it, is the material that is left behind when you bring pulp wood out, right.

Q. Right.

A. So I don't see why the cost would be much different to the cost of forest thinning. But no, we haven't looked at slash specifically, you are quite right.

Q. But although there is not a big difference in cost there is certainly a difference in environmental benefits when you clear out and burn for energy slash; correct?

A. In what sense?

Q. Well, maybe you could turn to page 8-8 of the CEC report. About midway down the page

there is a paragraph there that starts "Removal of forest residues has several positive environmental effects...", and then it lists them. So isn't it correct to say that use of -- harvesting of forest wastes, forest residues is an environmentally positive activity?

A. I think I would agree that there are those benefits there, though the negative side of it is that you do remove nutrients from the forest by removing the slash. So there are pluses and minuses.

Q. One of the benefits they have listed there is improved forest growth. That tends to suggest the removal of nutrients isn't really a bad thing.

MR. BURPEE: A. They are not similar forest types, though. I mean, Northern Ontario is arboreal forest, and I don't they how they can compare to this kind of forest. You would need a forest expert to tell you that.

Q. Okay. Now, Dr. Effer, like any other combustion technology burning biomass produces air emissions; right?

DR. EFFER: A. That is correct.

Q. And it is fair to say that the most significant air emissions are NOx and CO(2) for these technologies, biomass technologies?

A. The principle gaseous emissions, yes.

Q. And you control NOx and biomass generation basically the same way as you do for natural gas and coal, right - SCRs?

A. Yes. You can do, yes. And by appropriate boiler combustion.

Q. Low NOx burners?

MR. DAWSON: A. You can't control the NOx from a wood-fired boiler if it is a stoker-fired boiler by low NOx burners because they don't exist. The wood burns on the grate.

Q. So you would have to use SCR or something like that?

A. Yes. You can control the supply of combustion air under the grate relative to what you supply over the grate to some degree, but it is not as simple as a low NOx burner, put it that way.

Q. Is it fair to generalize that NOx as a problem for biomass is a fairly similar problem to NOx as a problem for natural gas and coal, and there is a menu of solutions that you have to work to?

A. I would have to go back and look at some data, but yes, generally they are of the same order. The lower plant efficiency due to wood waste may tend to push the NOx emissions up on a per

kilowatthour generated basis, but they are of the same order.

Q. Now, Dr. Effer, with respect to CO(2) if you look at the net CO(2) from biomass generation isn't that net generally very low, the net for the cycle?

DR. EFFER: A. On a theoretical basis the amount of carbon dioxide taken up by the vegetation will be released to the atmosphere by combustion, as I said in my direct.

But there is a small additional CO(2) which unbalances that equality, which is of course the transportation and general manipulation of the plantation. There is a fair amount of fossil fuels used there.

So in the overall operation there probably is some net emission of CO(2).

Q. From the vehicles, in effect?

A. Yes.

Q. But the plants are a carbon sync until you cut them down, and then when you burn them they release the same carbon that they brought in; right?

A. That's correct. And I also made the point in my direct that if that plantation replaced a

conventional fossil fueled generation, then there would be a negative CO(2) balance.

Q. It is a sort of an avoided emissions approach?

A. That is correct, yes.

Q. And, in fact, in the case of waste biomass if you just leave it to decompose it is going to release the CO(2) anyway, isn't it?

A. Yes, sooner or later.

Q. So is it fair to sort of generally conclude that biomass generation is relatively environmentally benign relative to other combustion technologies?

A. I think the main limitation if one looks beyond the emissions is that there may be certain problems connected with soil integrity, which we mentioned in direct, and as with many monocultures, the use of pesticides and herbicides may introduce complexities. But it has just been mentioned in the literature. I have no further information about it.

Q. And those are forest management issues; right?

A. That is correct.

Q. And if you do it properly you don't have those problems?

A. If you use the pesticides and the herbicides correctly, then you have no problem, yes.

Q. Just a couple of other questions. On energy from waste, Mr. Shalaby, you said that the energy from waste technologies, they are basically waste management technologies; correct?

MR. SHALABY: A. Yes.

Q. Just dealing briefly with landfill gas, you are familiar with the term BACT, best available control technology?

A. Yes.

Q. Is it true that energy generation of landfill gas is actually the best available control technology for landfill gas emissions from a landfill?

A. I don't know that for a fact.

Q. Dr. Effer, are you familiar with that?

DR. EFFER: A. I would have to get some definition of what best available control technology encompasses.

Q. Well, that is a --

A. From an environmental point of view.

Q. I thought it was a term of art and as the expert you would know it better than I did. BACT is a term you use all the time, isn't it?

A. Would you give me your question again, then?

Q. The question is: Is the burning of landfill gas to produce energy in fact environmentally the best available control technology for landfill methane emissions?

A. Yes.

Q. Okay. So I guess, Mr. Shalaby, one of my experts asked me this and I didn't have the answer.

Even forgetting the value of the energy why wouldn't you just build landfill gas facilities on every landfill right now just for control purposes, just so you don't have that methane going to the air?

MR. SHALABY: A. Why wouldn't Ontario Hydro do that?

Q. Or promote somebody else doing it. It doesn't matter.

A. Well, we are promoting the purchase of that energy from independent producers.

Q. Yes?

A. That is the end of my answer.

Q. Okay. It is a correct conclusion, isn't it, that the smart thing to do with landfills is burn the methane; right?

A. I have no difficulty with that, yes.

Q. I just have one other thing. If you could turn to Exhibit 500, this is a report from 1990 from the U.S. Department of Energy. These are some excerpts from it. It is quite long.

Mr. Shalaby, are you familiar with this report?

A. Yes, I am.

Q. Okay. Can you look at page Roman numeral 8 of that report? This is the Executive Summary.

A. Yes.

Q. Just before I ask any questions about the details of it, what's a quad?

A. A hell of a big number. I think it is 10 to the 15th--

Q. In the context --

A. --btu. It is 10 to the 15 British thermal units. The consumption of the United States is something like 100 quads or 80 quads or something like that.

Q. How would we convert that into megawatts?

A. It is the end of the day, Mr. Shepherd. I can't do that. Even at the beginning of

the day I can't do that. [Laughter]

Q. It is certainly thousands of megawatts; right?

MR. DAWSON: A. So divide by 10 to the fourth would convert it to kilowatts.

Q. Convert it to kilowatthours, you mean?

A. To kilowatthours, that's right.

Q. Yes. And then divide by eighty-seven-sixty to get kilowatts, or something like that?

A. Yes, something like it.

MR. SHALABY: A. If you can do that you are a lot fresher than I am.

Q. I purposely left my calculator back in the office. But it is correct that quads are thousands of megawatts; correct?

A. I will accept that, yes.

Q. If you look on page Roman numeral 9 of this report you see a chart there. It talks about the future contribution of renewables, and, in fact, you can see what DOE is talking about in terms of renewables on the previous page where it has a chart with the various components of renewables; right?

Now, it is correct, isn't it, Mr.

Shalaby, that there is very little new hydro power development going on in the United States?

A. Not according to this report. They see hydraulic power for the developed -- as far as I can gather, towards the end of your exhibit they show increasing hydro power.

Q. Yes?

A. Not significant, but there is a small increase.

Q. Not like it was in the past; right?

A. Well, in one of the scenarios it shows an increase from 3.1 quads to 5.1 quads over a 50 year period. So that is sort of a 60 per cent increase.

Q. Okay. Perhaps we could turn to that page. It is page 43, I think is the place where you can see the technology breakdown.

It is correct, isn't it, that for these various renewable energies the DOE is projecting under various scenarios many thousands of megawatts of each of them over the sort of 40 year horizon they are looking at; correct?

A. You have got to understand what these scenarios mean. R&D intensification, national premiums, I think it is.

But yes, under most scenarios they are expecting large increases over the next 50 years, yes. [4:45 p.m.]

Q. Now, these increases, understanding that the United States is a lot bigger than Ontario, these increases, when you scale them down, are still far and away larger than any of the projections that Ontario Hydro has made for any of these technologies; is that correct?

A. We haven't done to the year 2030. Probably the more appropriate comparison would be to look at page 42, which shows increases to the year 2010, for example. And then you do the prorating between the United States and Ontario, which is a factor of 25, or something, and I can't do all of that in my head.

Q. Is it correct, though, for example, they have got 1.7 quads of wind power, if you translate that all through, that's still a lot more than you are projecting; right?

A. Most likely is, yes.

Q. On the other hand their hydro power number of 4.2 quads, do you see that there? That's actually less than you are projecting, is it, if you do the ratio?

A. It's too much to convert between quads in U.S. and Ontario. It is just too much work.

Q. Fair enough.

DR. CONNELL: Just to clarify that. Opposite wind power it doesn't specific electric, I suppose that might embrace other forms.

MR. SHEPHERD: Oh, yes. In fact, these numbers are all forms of energy. They include transportation fuels, et cetera.

DR. CONNELL: Is there any breakdown as to what proportion of the wind power is electric?

MR. SHEPHERD: There is a detailed analysis, although I think that the conclusion - and maybe Mr. Shalaby has the report there - I think the conclusion with respect to wind would certainly be that the vast majority of it would be electric. But Mr. Shalaby has the whole report right there.

DR. CONNELL: There are no wind-powered cars envisaged? [Laughter]

MR. SHALABY: No.

DR. CONNELL: Thermal churns, I suppose, would be in there.

MR. SHALABY: I am not sure if there is any pumping or mechanical pumping. I am not recalling immediately what all the applications are.

If it's of sufficient interest, Dr. Connell, we can undertake to find out.

MR. SHEPHERD: Q. In terms of its level of adoption of renewable technologies in its plans over the next quarter century, would you say that Ontario Hydro is one of the more aggressive utilities or less aggressive as compared to other North American utilities or planners?

MR. SHALABY: A. There are utilities that are more aggressive than we are and there are utilities that are less aggressive than we are.

Q. Where do you rank in the scale?

A. I don't know if there is a scale. But they often mention utilities in California that are pursuing alternatives with more success than Ontario is, because they have the resource, which is one of the reasons, geothermal, for example, solar and wind.

Q. That's also because of a different policy environment?

A. Yes. And some policy environment, the regulatory environment is pushing in that direction, yes. And some other utilities are doing much less than we are.

Q. And the different policy environment that you see in places like California that produces

more renewable energy, that's largely environmentally-driven; is that correct?

A. I think it comes under the heading environmental-driven.

Q. Yes.

A. Some of it is ideological as well. But it goes under the banner of environmental.

MR. SMITH: A. I think your Exhibit 501 indicates quite clearly that part of the driver was to get off oil, a very substantial oil consumer for electric generation in the 70s. And if you look at your figure 1 on page 5 of Exhibit 501 and some of the verbiage in that exhibit, it quite clearly talks about one of the major drivers was to get off oil use, and that is both environmental and cost.

Q. And there was energy security at that time as well, wasn't there?

A. That's true.

Q. Of course there are also off coal; aren't they?

A. That's another question. I am glad you asked that question. You raised that question last week with Mr. Meehan in the transcript. And if I read this chart it doesn't look like they are getting off coal to me, but I don't have the details of the chart

and I don't have the reproduction in the original version. But if I read the chart it looks like it grows quite substantially between 1990 and the year 2009. I read the chart, I am assuming it's done in some rationale order, and the first dark box on the thing is imports, then oil and gas, then hydro storage and then coal, and it grows very substantially on that graph.

Q. All right. I didn't read it that way, but that's all right.

A. I don't have the original graph, so there are two black boxes on there and I can't tell which is which. But if you read the chart, I am assuming they would have gone around the circle in order, and that shows a very large black box which would be coal.

Q. So you are suggesting that coal use in California is actually growing?

A. All I am doing is reading this chart. I don't really know one way or the other.

Someone suggested to me at the break that in fact it might be coal use in another state for producing electricity in California which is an interesting approach they have taken.

MR. SHEPHERD: Okay. Those are all my

questions, Mr. Chairman.

DR. CONNELL: I would just like to go back to a matter that came up this morning when Mr. Shepherd was drawing to your attention some economic impacts studies. I believe two or three days ago we had evidence that none of you considered yourselves to be an expert on economic impact studies; is that correct?

MR. SHALABY: That's correct.

DR. CONNELL: So you wouldn't be able to criticize an economic impact study on grounds of methodology or assumptions?

MR. SHALABY: Not in detail, no.

DR. CONNELL: I think I am correct that secondary economic impacts are not reckoned into your cost benefit studies say with the alternative energy?

MR. SHALABY: They are not factored in there, no. You are correct.

DR. CONNELL: Right. This I don't think requires an expert perspective, but I think it's probably obvious that one could have an investment which was totally unproductive, which lead to no beneficial primary product, but yet had positive economic impact; is that correct?

MR. SHALABY: Yes.

DR. CONNELL: Thank you.

THE CHAIRMAN: Any further questions?

MR. SHEPHERD: No, Mr. Chairman.

THE CHAIRMAN: Mr. Grenville-Wood, you will be on tomorrow morning?

MR. GRENVILLE-WOOD: Yes, Mr. Chairman. I am ready to go bright and early.

THE CHAIRMAN: Thank you. We will adjourn then until tomorrow morning at ten o'clock.

THE REGISTRAR: This hearing will adjourn until ten o'clock tomorrow morning.

---Whereupon the hearing was adjourned at 4:55 p.m. to be resumed on Tuesday, March 3, 1992, at 10:00 a.m.

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